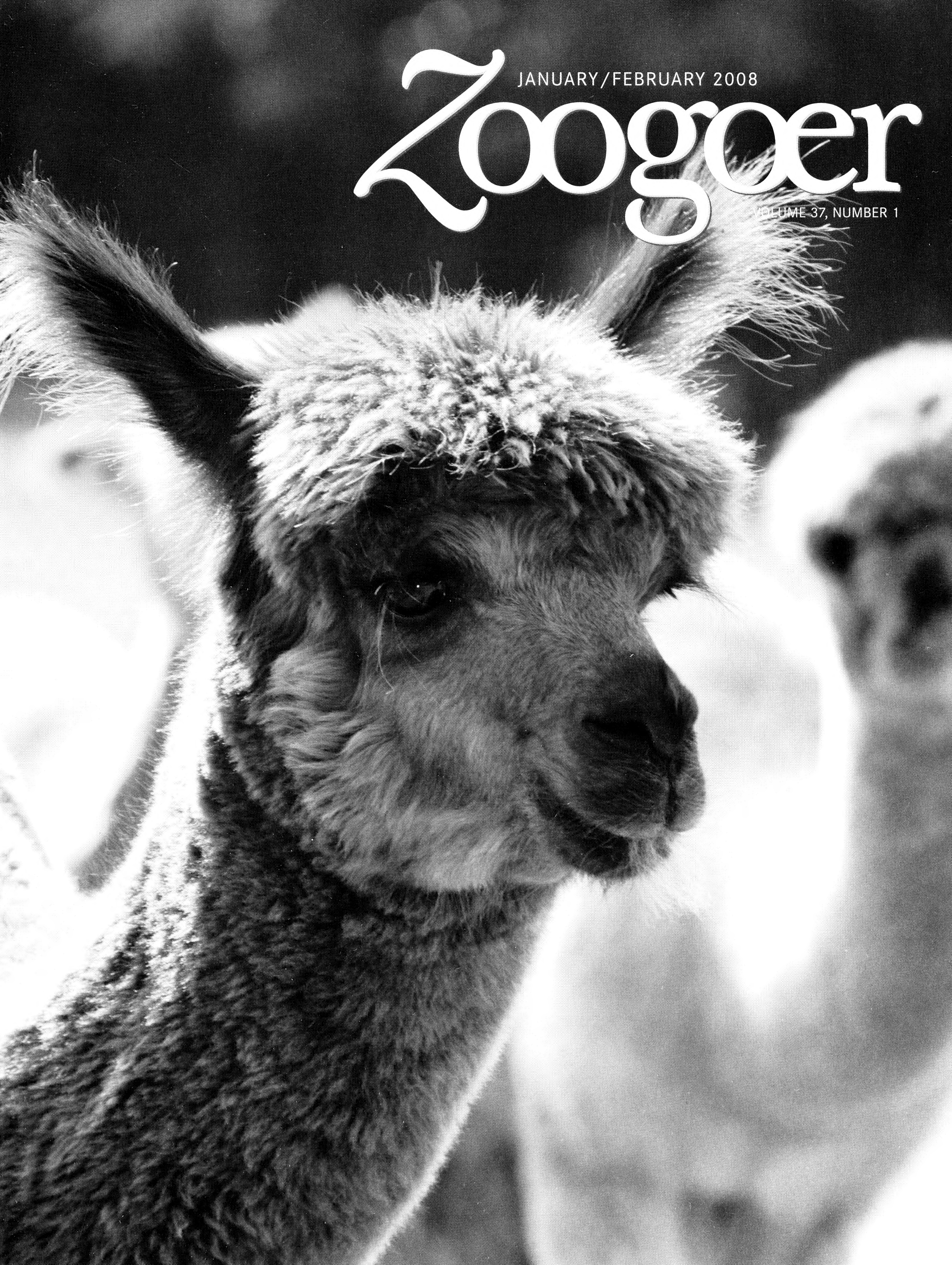


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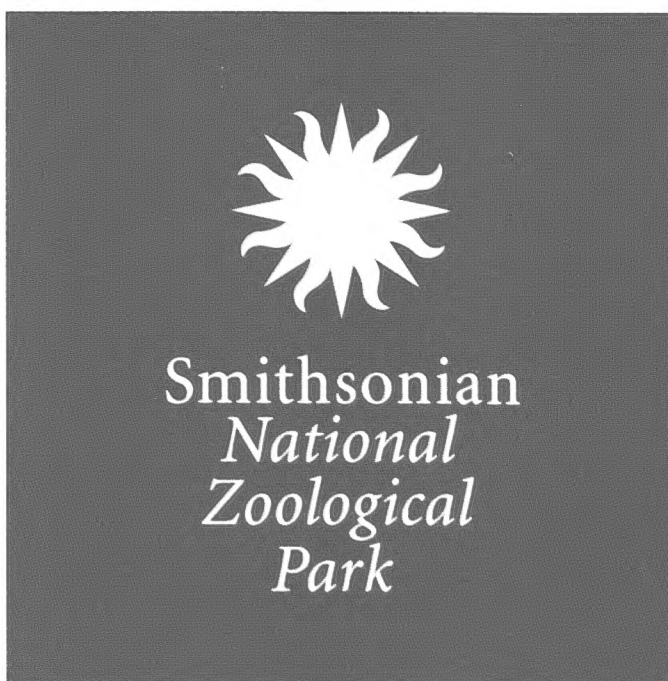
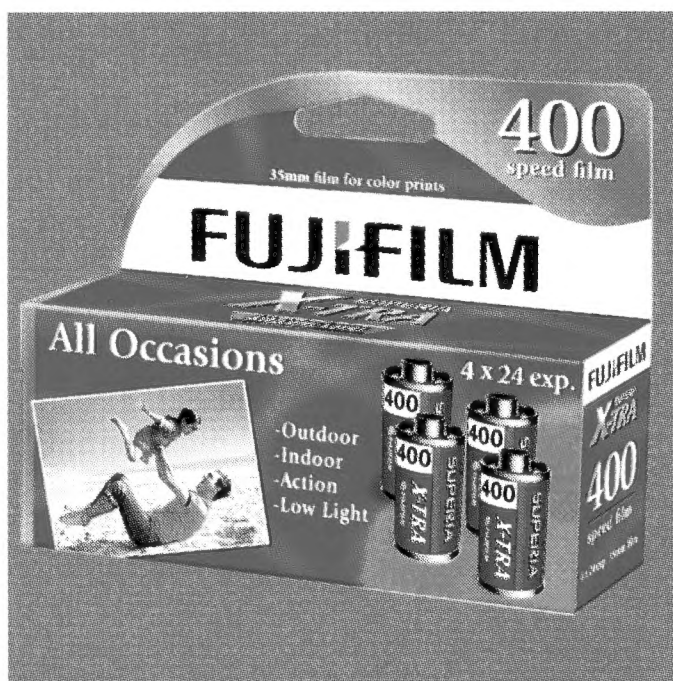
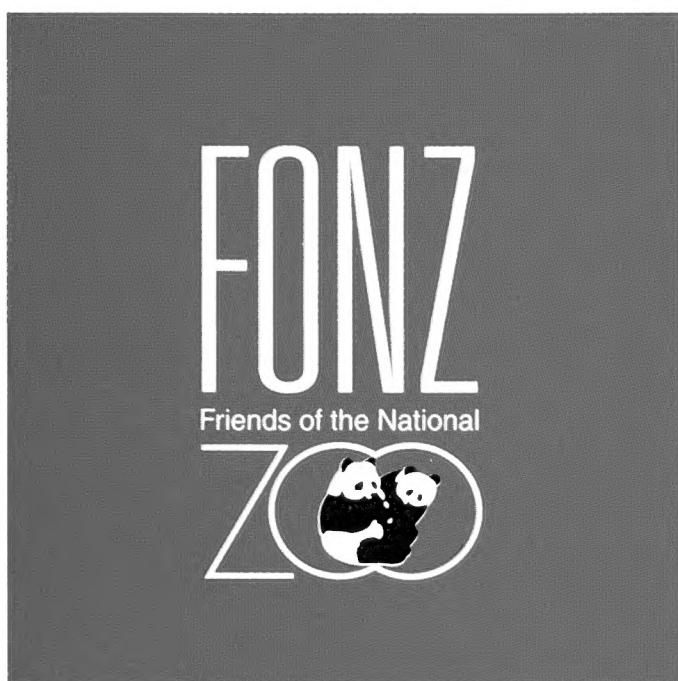
# Zoogoer

VOLUME 37, NUMBER 1





FUJIFILM



Fujifilm, the Smithsonian's National Zoo and Friends of the National Zoo are working together to help protect giant pandas and secure their future through education and research.

Visit and enjoy giant pandas Mei Xiang, Tian Tian and Tai Shan at the Fujifilm Giant Panda Habitat as well as six other Asian species along the Asia Trail.





# Zoogoer

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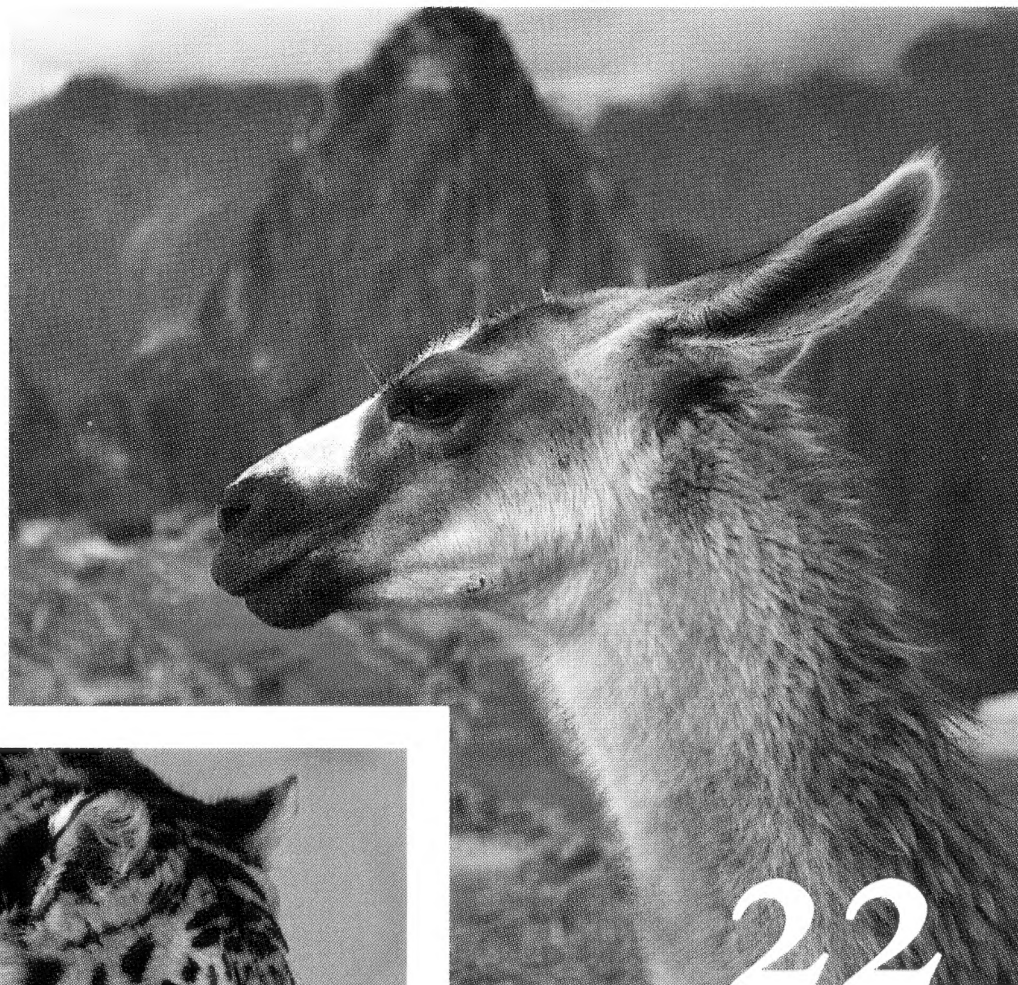
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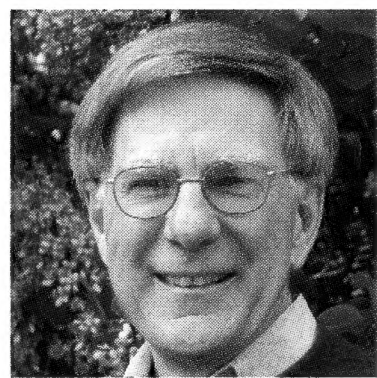
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# Looking Back, Leaping Forward



The dawning of a new year is a time to look back at last year's accomplishments and forward to goals and plans for the new one. For FONZ, this is especially important, because in 2007 the FONZ Board of Directors developed a new strategic plan and mission statement to guide our next 50 years. (See "Facing Fifty" in the July/August 2007 *ZooGoer*.)

So how did FONZ, the dedicated partner of the Smithsonian's National Zoo, do in 2007 to achieve its new mission of connecting people with wildlife?

- Our membership now stands at 40,000 households, which translates into more than 100,000 people devoted to wildlife and conservation.
- More than 1,800 volunteers contributed more than 105,000 hours to support FONZ and the Zoo.
- We posted record revenues from operations and fundraising of \$28 million for the year, and ZooFari, Brew at the Zoo, and Boo at the Zoo generated record attendance. This enabled us to fund education programs.
- More than 2.5 million people visited the Zoo and enjoyed refreshed gift shops, more diverse food choices, and greater assistance from knowledgeable information aides.
- There were nearly 25 million visits to the Zoo/FONZ website. About 25,000 students from around the world used activity and curriculum guides downloaded free.
- Education programs expanded. For instance, we offered sign-language classes to infants and toddlers for the first time.
- Our first Earth Day tree-planting and Stomp Out Carbon contest highlighted our commitment to sustainability and ways to slow global climate change.

So what's in store for 2008? We are planning events to celebrate our 50th birthday and highlight our history. But I believe the best way to mark this occasion is to work even harder at fulfilling our mission and to look to future impact, not just past glory.

For example, FONZ, along with the Zoo, is committed to participating in Year of the Frog activities (see "2008: The Year of the Frog" on the facing page). Watch for ways we are connecting people to frogs in this magazine, on the website, in our education programs, and even at special events, including this year's ZooFari—Frogs and Friends.

This year will also see the completion of a new facilities master plan for the National Zoo, and that signals the beginning of a huge task for us: raising funds to carry out the master plan and to make the Zoo the world's finest. So as FONZ continues to develop the resources needed to build Elephant Trails, refresh other exhibits, and support education and conservation programs, we will explore how best to help the Zoo bring its new plan to fruition.

It's an exciting time for FONZ to be entering its second half-century. The challenges of supporting the Zoo, conserving wildlife, and protecting the planet have never been greater. With FONZ members in the vanguard of a society committed to restoring an endangered natural world, I believe we can answer these challenges—and look forward to another generation marking FONZ's 100th birthday by celebrating the survival of frogs and all wildlife, not mourning their loss.

Sincerely,

Bob Lamb

Executive Director, Friends of the National Zoo



is the dedicated partner of the Smithsonian's National Zoological Park. FONZ provides exciting and enriching experiences to connect people with wildlife. Together with the Zoo, FONZ is building a society committed to restoring an endangered natural world. Formed in 1958, FONZ was one of the first conservation organizations in the nation's capital.

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**Membership** in FONZ offers many benefits: programs, publications, discounts on shopping and events, free parking, and invitations to special programs and activities to make zoogoing more enjoyable and educational. To join, write FONZ Membership, FONZ, P.O. Box 37012 MRC 5516, Washington, D.C., 20013-7012, call 202.633.3034, or go to [www.fonz.org/join.htm](http://www.fonz.org/join.htm).

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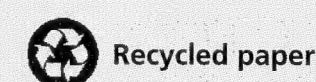
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An audio version of *ZooGoer* is available on our website, for members who cannot read standard print due to disability. For more information, please visit [www.fonz.org/zoogoer.htm](http://www.fonz.org/zoogoer.htm).

**On the cover:** Ziggy is one of three young male alpacas now on exhibit at the Smithsonian National Zoo's Kids' Farm. Photo by Jessie Cohen/NZP.

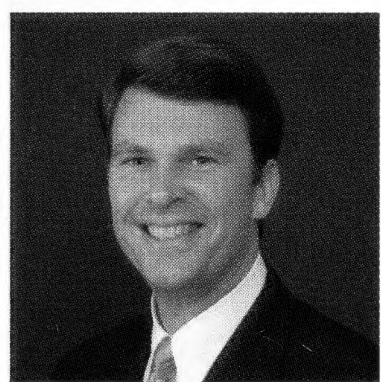


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# 2008: The Year of the Frog



Frogs are about to go the way of the dinosaurs: extinct. And not just frogs, but toads and salamanders and all amphibians, about 6,000 species that are beset by a host of problems, most of them of our making. Already, as many as 130 species have likely gone extinct. Another 450

or so are considered critically endangered and 1,400 are threatened. There are another 1,400 species whose status we simply don't know, and there are many species not yet known to science—and they may never be. Even generally dispassionate scientists label the widespread decline of amphibians a catastrophe in the making.

Awareness of this conservation crisis is still largely confined to the conservation community, however. That is why the Smithsonian's National Zoo and Friends of the National Zoo are joining with zoos in the Association of Zoos and Aquariums and the World Association of Zoos and Aquariums, the World Conservation Union (IUCN), and other conservation organizations to make 2008 the Year of the Frog. The goal is to inspire greater awareness of the crisis and to enlist the public's participation in solving it.

When there are so many other big environmental problems to solve, I can imagine many people asking why they should care about the future of a bunch of little frogs, toads, and salamanders. Because they share our planet is the short answer. The alarming state of amphibians is worrisome because these animals are the "canaries in the global coalmine." Living both on land and in water, and absorbing oxygen and water through their porous skins, amphibians may be among the first to suffer from air and water polluted with pesticides, herbicides, and other chemical contaminants. That the "canaries" appear to be dying does not bode well for the rest of us. As Indira Gandhi once said, "An environment in which animals and plants become extinct is not safe for human beings either."

Apart from pollution, amphibians are declining due to other human-induced environmental impacts: habitat loss and land-use change especially, but also invasive species and excessive harvesting for the pet trade and for food and medicine. This litany of problems is so pervasive, and affects so many species, that some scientists were concerned about amphibian declines but not surprised by them. Seeing frogs disappear from large, relatively pristine protected national parks and wilderness areas was a wake-up call to a bigger problem.

The novel threat that has emerged is a fatal infectious disease affecting frogs around the world. Called chytridiomycosis, it is

caused by a microscopic fungus. The fungus and the disease were first described by a team of scientists at the National Zoo in 1999, about the same time another group of scientists implicated the disease in the disappearance of frogs in Central America and Australia. Now the disease, which attacks amphibians' sensitive skin, has been associated with the decline or extinction of nearly 100 species worldwide, and who knows how many others that no one is monitoring. Some scientists suspect that this epidemic may be related to climate change.

Panamanian golden frogs are one example. These beautiful toads were under pressure from loss of habitat and overcollection for the pet trade, but the chytrid fungus was devastating, and so few individuals remain in the wild that the species is effectively extinct. Fortunately, zoos, including the National Zoo, in cooperation with colleagues at the Smithsonian Tropical Research Institute and others, stepped in to save them through a breeding program. The Zoo now has one of a handful of self-sustaining breeding populations of Panamanian golden frogs.

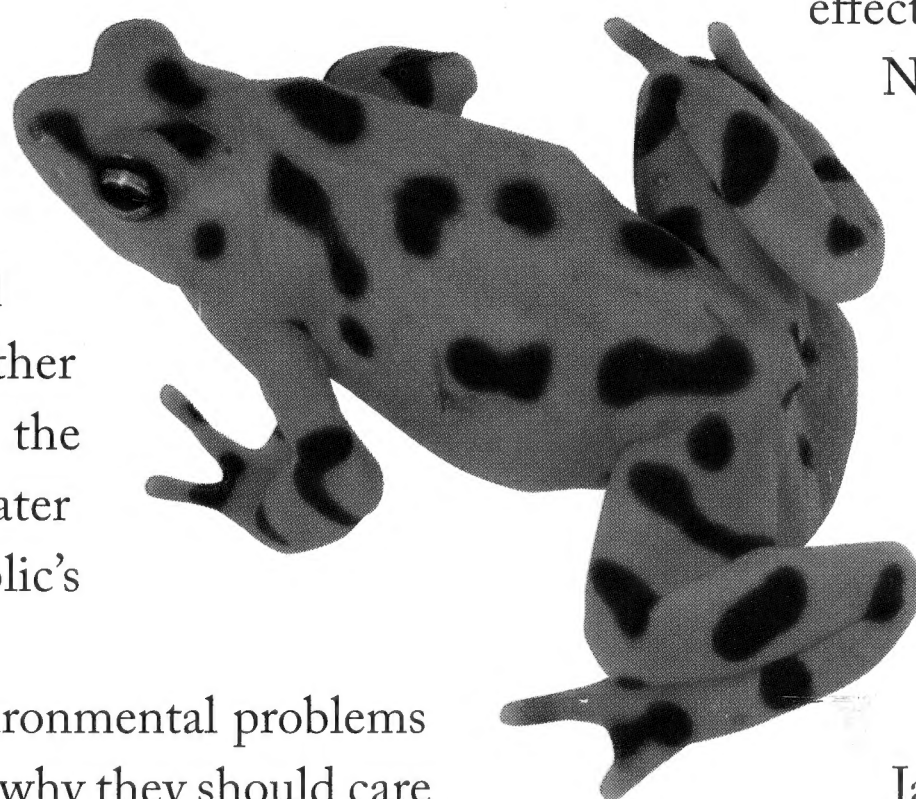
Throughout the Year of the Frog, we will be telling you about other National Zoo programs to help disappearing amphibians, including the launch of a breeding program for Japanese giant salamanders, one of which is now exhibited on Asia Trail. We'll also be talking about things all of us can do in our everyday lives to staunch amphibian declines, which are happening around the world and in our own backyards. In ways large and small, we can all make a difference.

We are facing the extinction of an entire class of vertebrates, a loss of a magnitude unprecedented since dinosaurs vanished from the face of the Earth and one likely to have profound ecological consequences. But human action—or inaction—will determine the fate of frogs. The National Zoo's mission is to leave a better world, abundant with biodiversity, to our children and grandchildren. We won't succeed unless we can save amphibians. And we can't succeed without your participation and support for our efforts. Leap into the Year of the Frog.

Sincerely,

John Berry

Director, Smithsonian's National Zoological Park







Cirrus (above) and two other male alpacas, along with female Ossabaw Island hog Carolina (below) and her sister Savannah, debuted at the Kids' Farm at the Smithsonian's National Zoo in late 2007.

## Animal News

Three male alpacas debuted at the Smithsonian National Zoo's Kids' Farm in December, typically one of the chillier months of the year in Washington, D.C. But alpacas are no strangers to cold climates—their thick coats keep them warm in the high elevations of their native South American habitat. People domesticated alpacas thousands of years ago and today the animals are bred around the world for their fine fiber, which is woven into textiles. Check out “Discovering South America's Camels” on page 22 to learn more about alpacas and their wild cousins.

The Kids' Farm alpacas are between eight months and two years old and they came to the Zoo from Morning Moon Alpacas in Remington, Virginia. Ziggy's coat is brown, Orion's is fawn-colored, and Cirrus' is white. They have chambered stomachs and chew their cud just like the Holstein and Hereford cows that share their pasture.

Two female Ossabaw Island hogs from George Washington's Mount Vernon Estate and Gardens in Mount Vernon, Virginia, also went on exhibit at the Kids' Farm in

December. Spanish explorers brought the ancestors of these hogs to Ossabaw Island off the coast of Georgia about 400 years ago. Unlike hogs the Spanish brought to North America's mainland, feral Ossabaw Island hogs did not mate with other domestic pigs, so they retained much of their Spanish genetic heritage. The Kids' Farm hogs are sisters named Carolina and Savannah. They are four months old and are both black.

Two pairs of northern tree shrews (*Tupaia belangeri*) went on exhibit in late November in the Small Mammal House. Northern tree shrews are native to Southeast Asia and eat mostly fruit and insects. Like North American squirrels, they are both arboreal and terrestrial. In fact, they so closely resemble squirrels that their genus name is derived from a Malay word for “squirrel,” but their snouts are longer and their whiskers are shorter than squirrels'. *T. belangeri* parents build one nest for themselves and a separate nest for their young.

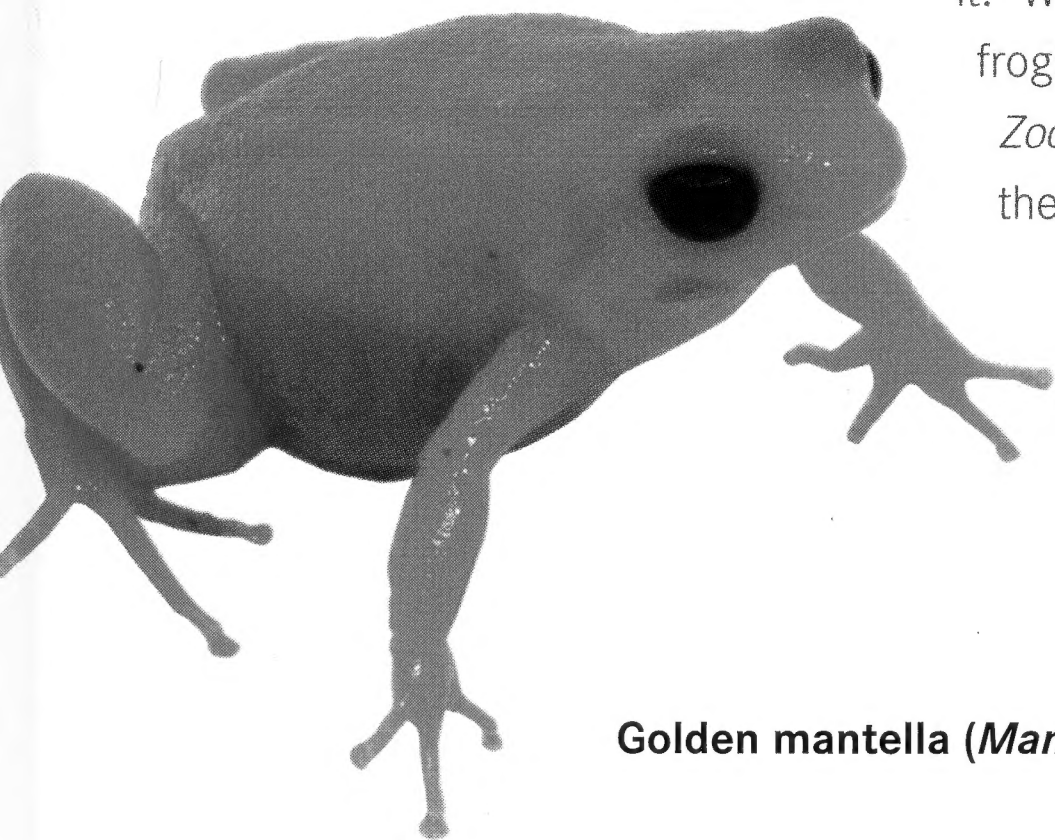




## Year of the Frog

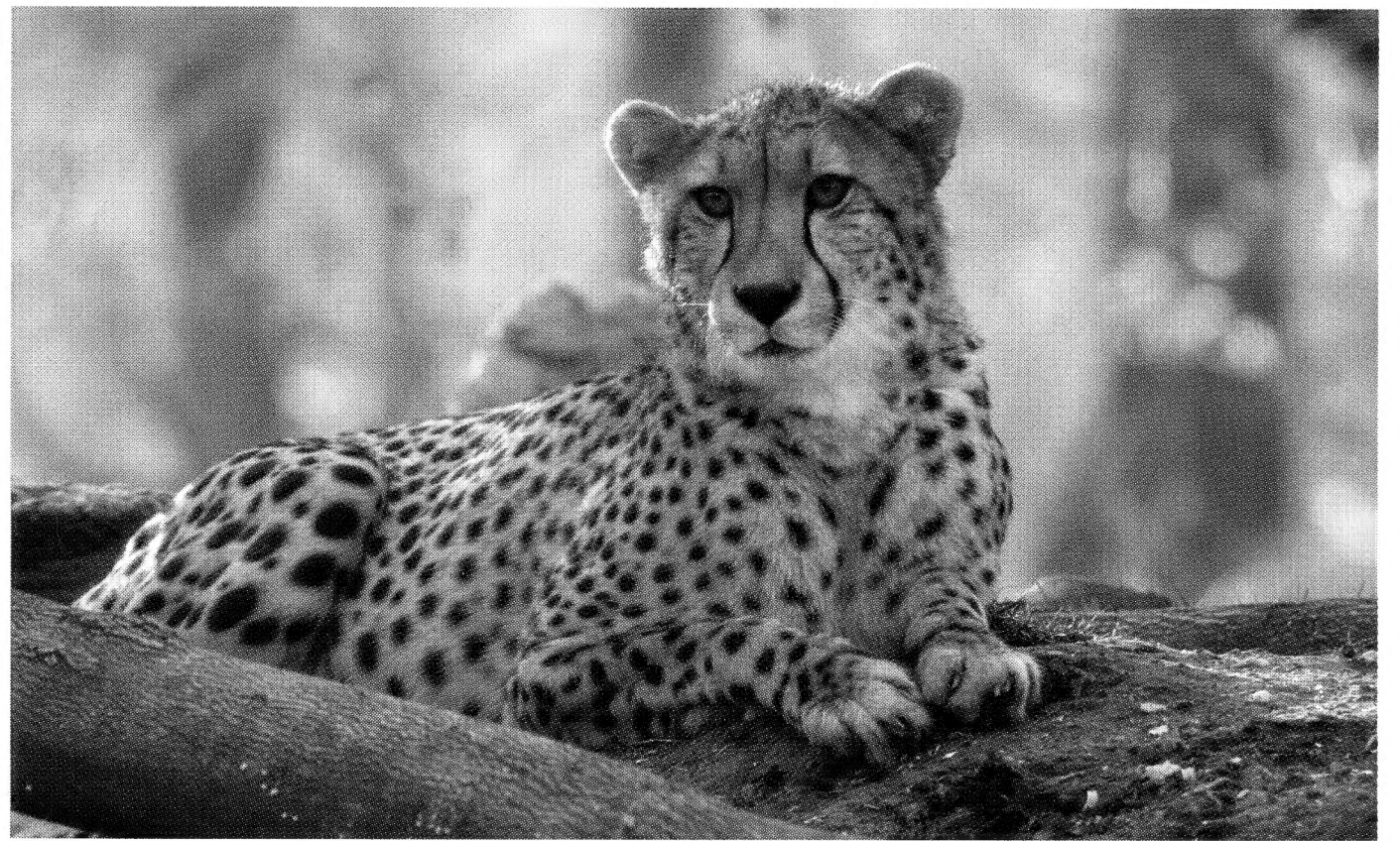
Did you know that as many as 130 amphibian species have already gone extinct, and another 450 or so are critically endangered? The loss of so many frogs, toads, salamanders, and other amphibians is rapidly becoming a global ecological disaster. That's why FONZ and the Zoo are proud to participate in the Year of the Frog, a campaign created by the Association of Zoos and Aquariums and the World Association of Zoos and Aquariums, The World Conservation Union (IUCN), and other conservation organizations to raise greater awareness about the amphibian

crisis and to find ways to solve it. Watch for a story on frogs in your next issue of *ZooGoer*, and throughout the year we'll update you on ways you can help conserve these incredible animals.



**Golden mantella (*Mantella aurantiaca*).**

## Cheetahs Need Our Help



Cheetahs are in a tight spot. Although they once ranged from Africa through Central Asia and beyond, fewer than 15,000 now live in isolated populations in Africa and Iran. National Zoo scientists are working hard to help cheetahs in the wild, at the Zoo in Washington, D.C., and at the Zoo's new Cheetah Science Facility in Front Royal, Virginia, but they need help. With your support, the Zoo can provide a brighter future for cheetahs. To learn more and to contribute to FONZ's cheetah campaign, visit [www.fonz.org/savecheetahs.htm](http://www.fonz.org/savecheetahs.htm).

## On Our Website

You can find animal updates, learn about wildlife and conservation, and get the inside scoop from animal keepers, curators, veterinarians, and scientists on our website. Visit [www.fonz.org/zoogoer.htm](http://www.fonz.org/zoogoer.htm) to:

- Read the journal of a Washington, D.C., high school student sent by the Zoo to the Arctic to study polar bears.
- Watch a video to see how a Zoo scientist is uncovering the way orangutans think.
- Get tips from the Zoo's Green Team on making environmentally friendly decisions.

photos.com



## Volunteer Corner



**Wallabies are among volunteer Marion Zirbel's favorite Zoo animals.**

FONZ volunteer Marion Zirbel has traveled all over the world to places like Zimbabwe, New Zealand, Hungary, Botswana, and several countries in the Middle East, but her heart truly lies in Australia. "It's my favorite place in the world," she says. Marion has been down under four times, but while she's at home in D.C., she maintains her connection to the outback

by serving as a keeper aide for the wallabies and emu at the Zoo.

Marion also leads tours as a Zoo guide, which in its own way strengthened her connection to Australia. In 1992, she gave a tour to visiting members of the Melbourne Zoological Society. Since then, she has kept in touch with the married couple who were president and vice president of the group. She visited them in Australia on one of her trips, and hosted them on a return trip to D.C.

Outside of her volunteer activities, Marion has had a long career

in information technology and now works as a project manager for Northrop Grumman. Luckily, her job also involves some travel.

Do you have wanderlust, too? By volunteering at the Zoo, you can work with animals from around the world. Visit [www.fonz.org/volunteer.htm](http://www.fonz.org/volunteer.htm) to find out how.

—Molly Woods





The Dalmatian pelican (*Pelicanus crispus*), a species considered vulnerable by the World Conservation Union (IUCN), breeds on the Iraq marshes, which were drained by Saddam Hussein in the 1980s. The global loss of wetlands has stressed wildlife populations, but conservation efforts look promising.



# **RIISING WATER**

## **RESTORING RUINED WETLANDS**

by Brendan Borrell

Less than a month after Saddam Hussein's regime fell in April 2003, the first trickle of water seeped back into the soil of a former marsh near Basrah in southern Iraq. The draining of this marsh and a massive network of connected wetlands, masterminded by Hussein in 1993 to quell and punish a rebellion by his Shiite opponents in the south, was both a cultural and a biological tragedy.

Satellite images from 2000 revealed grayish-brown patches where the marshes once were: dead reeds, desert shrubs, and dry ground. A region that once was an oasis for millions of birds was now desert. A mere 12 percent of the original marshes remained.

Unfortunately, these marshes are but one example of the accelerating decline of wetlands worldwide. For centuries, fresh and saltwater wetlands have been drained for agriculture and industry or converted for human settlements, but the pace has quickened in the last 50 years due to growing coastal sprawl. Engineers long believed wetlands were a waste of water and breeding places for disease-carrying mosquitoes and other pests, and with the encouragement of government officials they diverted water, filled in bogs, and laid down pavement to stimulate economic development.





**The Ma'dan, or Marsh Arabs, and their ancestors depended on the once-abundant marshes for millennia, but in just one decade their way of life was destroyed. An estimated 70,000 Ma'dan were forced to flee to Iran during Hussein's reign.**

**Y**et wetlands provide invaluable benefits to people and wildlife. They form transitional zones between terrestrial and aquatic ecosystems, providing indispensable habitat for much of the world's biodiversity. They help control floods by buffering flood basins from heavy rainfall, letting water percolate out of soils gradually. They filter out contaminants from agricultural and municipal runoff before it drains into rivers, lakes, and aquifers. They provide crucial stopover points for wide-ranging migratory birds, and almost one-third of the world's endangered plants and animals depend in some way on their existence. And estuarine areas, where rivers meet the sea, serve as nurseries for coastal fisheries, which supply as much as two-thirds of worldwide harvests.

In 1996, the Organization for Economic Co-operation and Development (OECD) published estimates that more than half of the wetlands in the United States and Europe were destroyed or polluted between 1900 and 1985. Wayne Henley of the Massachusetts Audubon Society suggested in 1965 that with the pace of coastal wetlands destruction, New Englanders should consider making clam chowder out of tomatoes. In Asia, huge swaths of wetlands have been converted into rice monocultures. The OECD also reported that, taking into account undeveloped regions in Africa and South America, an estimated 26 percent of wetlands had been lost worldwide between 1900 and 1985. That number is likely to rise in the near future. There are plans, for instance, to dredge the Paraguay and Paraná rivers to facilitate shipping among five South American countries, a project that would devastate Brazil's Pantanal, the world's largest wetland.

While there is much debate about the degree to which lost wetlands can be restored, few would disagree with the need to recover—to the extent possible—many of the wetlands that have been lost over the last century. In Iraq, local communities are working with scientists and conservationists to restore the marshes destroyed by Hussein. Their efforts are mirrored in restoration projects around the world, from the wetlands bordering the remnant Aral Sea in Kazakhstan and Uzbekistan to the flood plains of the Illinois River and the coastal marshes around the Chesapeake Bay. Whether the destruction of these wetlands was precipitated by political events or agricultural demands, we are finally recognizing that wetlands provide economic and cultural value to our landscapes.

## **Iraq: Between Two Rivers**

The Iraq marshes once covered almost 6,000 square miles, twice the size of the Florida Everglades. They lie between the Tigris and the Euphrates rivers in an area called Mesopotamia, which has long been considered the cradle of civilization. Mesopotamia is the birthplace of the world's first writing system, and may have been the physical location of the Garden of Eden.

Azzam Alwash, an Iraqi-born engineer who has led restoration efforts in the region, grew up on the marshes in the 1960s. He remembers laying his head on the edge of his father's boat and staring at the giant reeds extending toward the sky. "I saw skies full of birds," he says. He recalls seeing the dark shapes of huge fish in the water—a rich community ranging from algae-eating bunnies



(*Barbus sharpeyi*) to predatory catfish (*Silurus triostegus*). “I fell in love with the marshes at the time,” he says.

But Hussein, who took power in 1979, viewed the marshes as a thorn in his side. During the Iran-Iraq War in the 1980s, deserters from his army sought refuge in the marshes, and the region later became a hiding place for Shiite refugees and rebel fighters.

In 1991, southern Iraqis threatened to rise up against Hussein. In response, he ordered construction of the “Third River,” a canal that would divert water around the marshes. His regime’s official explanation for the project was to irrigate half a million square miles of fields—an idea originated by British engineers in the 1950s. The 1990 completion of the Ataturk

Dam, which Turkey built upstream on the Euphrates for both irrigation and hydroelectric power, had indeed significantly limited water flowing into Iraq’s interior. But experts said that the Third River and its accompanying diversions went beyond irrigation needs and were specifically intended to eliminate the marshes.

As the marshes dried, an estimated 70,000 Ma’dan, or Marsh Arabs—a people who fished, raised water buffalo (*Bubalus bubalis*), wove reed mats, and cultivated rice and barley on the marshes as their Babylonian and Sumerian ancestors had 5,000 years ago—were forced to flee to Iran. Fisheries that once provided the bulk of Iraq’s annual catch collapsed. The Basrah reed warbler (*Acrocephalus griseldis*), which breeds exclusively in the marshes, was brought to the cusp of species-wide extinction, while populations of the marbled teal (*Marmaronetta angustirostris*) and other bird species considered vulnerable by the World Conservation Union (IUCN) were nearly wiped out locally.

Alwash and his wife, Suzie, were living in California when they heard about the devastation. They were shocked. In 2000, they began drawing up plans for a nonprofit organization called Eden

Again, which would supply Iraqi organizations with scientific support for restoration efforts. At that time, U.S. gov-

ernment scientists thought it was too late for restoration: The Ataturk Dam was already diverting too much water from the Euphrates, and the former marshes were blanketed in a layer of salt that prevented plants from taking up water and nutrients. The marshes were also strewn with leftover ordnance, land mines, and other battlefield debris from the Iran-Iraq War.

The Alwashes were not deterred. It was nearly impossible to get accurate information on the state of the marshes, but the couple spent

weeks in libraries searching for data on water flows and the design of Hussein’s canals. Alwash consulted extensively with his father, a former irrigation engineer who had been living in Washington, D.C., since the first Gulf War. They set up their own blue-ribbon panel of eminent wetlands scientists who were more optimistic about recovery, but were concerned that the marshes were contaminated by heavy metals and pesticides from agricultural and industrial runoff. In addition, small villages and farms that had sprung up on the edge of drained marshes would be destroyed if the marshes reflooded. Chief scientist Curtis Richardson from Duke University in Durham, North Carolina, said at the time, “If

we can restore one-third of the marshlands, I would consider it a miraculous recovery.” The panel recommended a three-month monitoring period to test for chemical pollution.

But that monitoring period never happened. Instead, shortly after the fall of Hussein, residents and returning Ma’dan quickly razed the extensive dikes and dams blocking the flow of water. Richardson joined Alwash on the first team to visit the marshes after the initial 2003 flooding. The group was first led by U.S. military experts and later by local Kurdish guards. It was a dangerous endeavor, but the political sentiment among Iraqis was still one of optimism. When Richardson arrived, he saw that parts of the marsh had been so badly burned by Hussein’s forces that the sandy soils had turned to glass. Local people came up to the convoy and begged for water.

Seeing this, Richardson remained skeptical about the prospects for the reflooded marshes. But then, he says, “We got to those lakes and to our surprise there were two feet of clam shells,”—the marshes were coming back to life. By February 2004, nearly 20 percent of the former marshes were reflooded, and vegetation cover was expanding at a rate of 300 square miles a year.

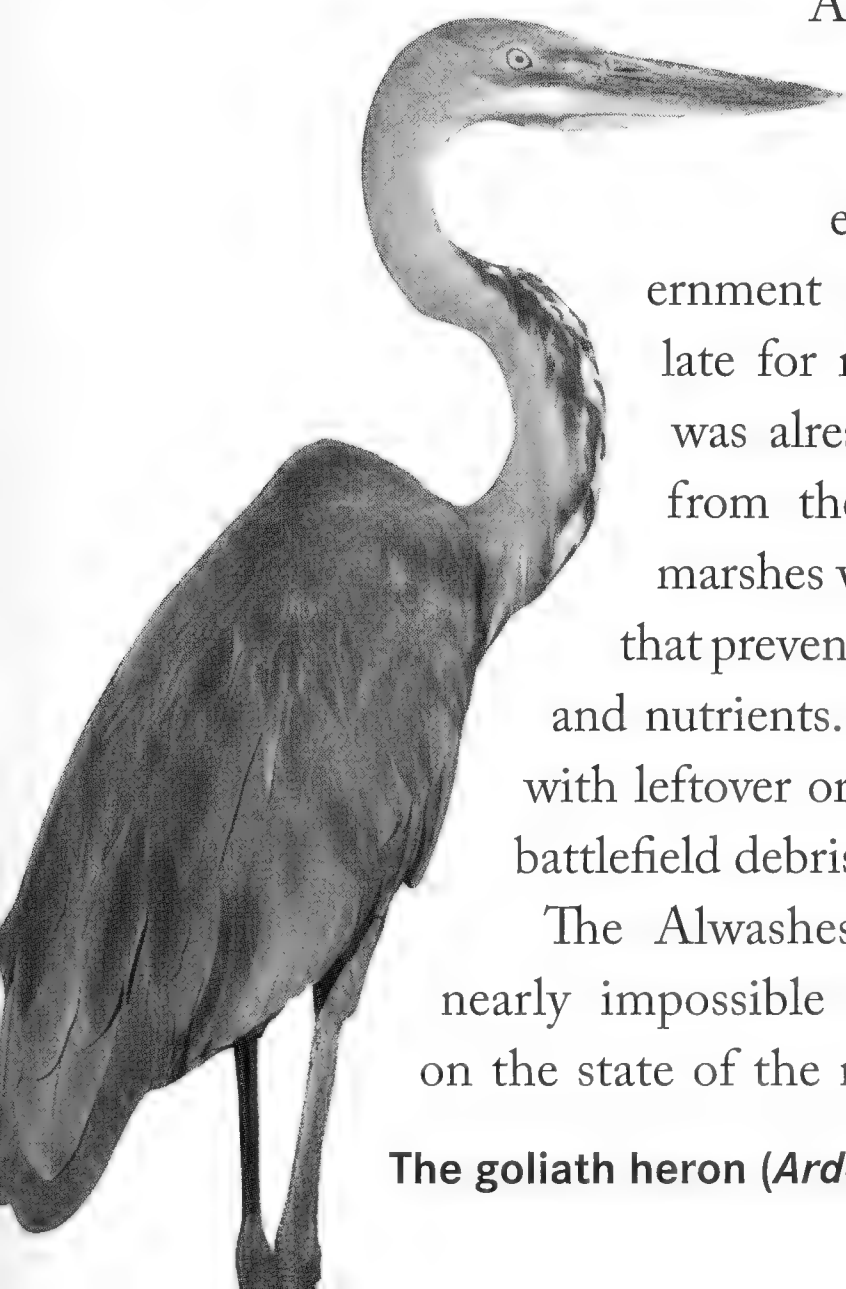
Richardson’s analysis, which was published in the journal *Science* in 2005, alleviated the scientists’ major concerns. Pesticides and other toxins were not detected in four marshes they sampled, and they found the water was well-oxygenated—meaning it wasn’t getting choked with algal growth. As expected, there were high levels of salt in the soils and salt-tolerant plants such as saltbush (*Atriplex* sp.) and the Athel tree (*Tamarix aphylla*) were thriving throughout the region. High levels of sulfates—a naturally occurring mineral in brackish water—were only discovered in the eastern portion of one marsh, possibly inhibiting the establishment of vegetation in that area.

Omar Fadil is a Baghdad-based ornithologist with the nonprofit organization Nature Iraq, which has been working with Eden Again to restore the marshes. Fadil says he has seen plenty of cormorants and ibises, and in the last year witnessed the return of the imperial eagle (*Aquila heliaca*), a migrant. Ornithologists also report the return of the Iraq babbler (*Turdiodes altirostris*), a species not seen in

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**We are finally recognizing that wetlands provide economic and cultural value to our landscapes.**

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The goliath heron (*Ardea goliath*) breeds on the Iraq marshes.



the area in decades. Members of the restoration teams have reported wild boars and are keen to discover whether the rare Maxwell's, or smooth-coated, otter (*Lutrogale perspicillata*) has survived.

Although the marshes seemed to be thriving on the surface, the situation was more complex underwater. A healthy ecosystem resembles a pyramid with small numbers of predators at the top supported by large numbers of herbivores. But the team's surveys revealed that the aquatic ecosystem was out of whack, because of the lack of aquatic plants and invertebrates to support the herbivorous bunni, which historically was the fish with the greatest commercial value. Instead, the marshes were dominated by the piscivorous catfish, which is not eaten by the Ma'dan because of religious reasons. This lack of food resources has prevented the Ma'dan from resettling much of the marsh's interior.

The biggest hurdle now is finding a way to recreate the hydropulse, a seasonal flooding of the marshes caused by snowmelt flowing down from the mountains of Kurdistan. Extensive networks of dams in both Iraq and Turkey now block this hydropulse, which once renewed the marshes by increasing the water level, pushing brackish water out, and bringing in silt and clay. It coincided with fish spawning and bird migrations and a flush of new growth by the reeds. By September 2007, the marshes were about 68 percent flooded, but because there is less overall water in the system, Alwash and his engineers are realizing they will need to bring the hydropulse back mechanically, properly timing the release of water

**The imperial eagle and other migrant bird species are returning to the revitalized Iraq marshes.**



Hanne & Jens Eriksen/naturepl.com

from dams. "It's like a symphony, really," he says. "If we don't return the hydropulse, I am not saying the marshes will die, but there will be a different system that will evolve."

With the continuing war in Iraq, it is becoming harder and harder to keep tabs on the marshes. Alwash says he has a team going out once a month, but kidnappings throughout the country rose soon after the first surveys. In 2004, five students from the University of Basrah were kidnapped while birdwatching on the marshes, although they were eventually released unharmed. "I was hoping I could take my wife and kids to the marshes, but southern Iraq is not very safe at this point," Alwash says. "Who knows? Maybe in two, three, four years things will settle down, and I can take my kids and show them the marshes, and maybe they'll fall in love like I did."

## **Kazakstan and Uzbekistan: A Vanishing Sea**

The Ma'dan were unable to combat the government-mandated destruction of the Iraq marshes in the 1990s. Thirty years earlier and thousands of miles north of Iraq, a similar cataclysm began when the long arm of Soviet Moscow turned the spigot off on the Aral Sea in Central Asia.

Twenty miles of sand now lie between the port town of Aralsk in Kazakstan and the northernmost reaches of the Aral Sea, once a vast saltwater lake that has shrunk to half its former size. Aralsk is filled with remnants of a former era: vacant docks and fish processing plants left behind as the Aral's waters receded. A small museum highlights the region's once-rich cultural and biological heritage. Inside, a ghostly looking shovelnose sturgeon (*Scaphirhynchus platyrhynchus*) is on display in a test tube. This evolutionary relict used to occasionally venture down the Syr Darya river into the waters of the Aral Sea, but it may now be extinct, according to sturgeon expert Phaedra Doukakis of the Pew Institute for Ocean Science in Miami, Florida.

In the 1950s, Aralsk and other ports along the sea processed 50,000 tons of fish a year, but the catch has declined drastically since then. By the early 1990s, the Aral Sea was biologically dead. Experts predicted that it would dry up completely by 2020.

The decline of the Aral Sea began in the 1960s when Moscow embarked on a plan to irrigate millions of acres of cotton in the desert of Kazakstan, Uzbekistan, and Turkmenistan, which at the time were part of the Soviet Union but are now independent countries. The Soviet government diverted water from the two rivers that flowed into the Aral—the Syr Darya in the north and the Amu Darya in the south. By the early 1980s, the irrigated land was producing nine million tons of cotton a year, making Central Asia the world's fourth-largest producer of cotton. As a result, the level of the sea dropped and the water became increasingly saline. In 1988, the lake split into a northern basin and a much larger southern basin.



For a while, local fisherman tried to preserve their way of life, but sturgeon and other native fish were no longer able to survive in the salty waters. Dust storms whipped up salty sediment and pesticides from the exposed seabed, and local people told of walls of sand blowing through their towns. People in these areas have since been racked with respiratory diseases such as tuberculosis, while rates of cancer and other diseases have skyrocketed.

Biodiversity suffered as well. Along both river deltas, forest communities called tugai were once dominated by flood-tolerant Euphratica poplar trees (*Populus euphratica*), but a century of agricultural development coupled with the dire water situation wiped out almost 90 percent of them. The region once boasted 576 species of plants, but 54 are now nearing extinction. The reed thickets in the Amu Darya delta also vanished. By the 1990s, the endangered Bukhara deer (*Cervus elaphus bactrianus*), a resident of both river valleys, numbered less than 400. Other mammals, such as the jungle cat (*Felis chaus*)—possibly the only cat that barks—were faced with a rapidly shrinking habitat. Of the 70 mammal species and 319 bird species once recorded from the Aral Sea, experts estimate that less than half remain today.

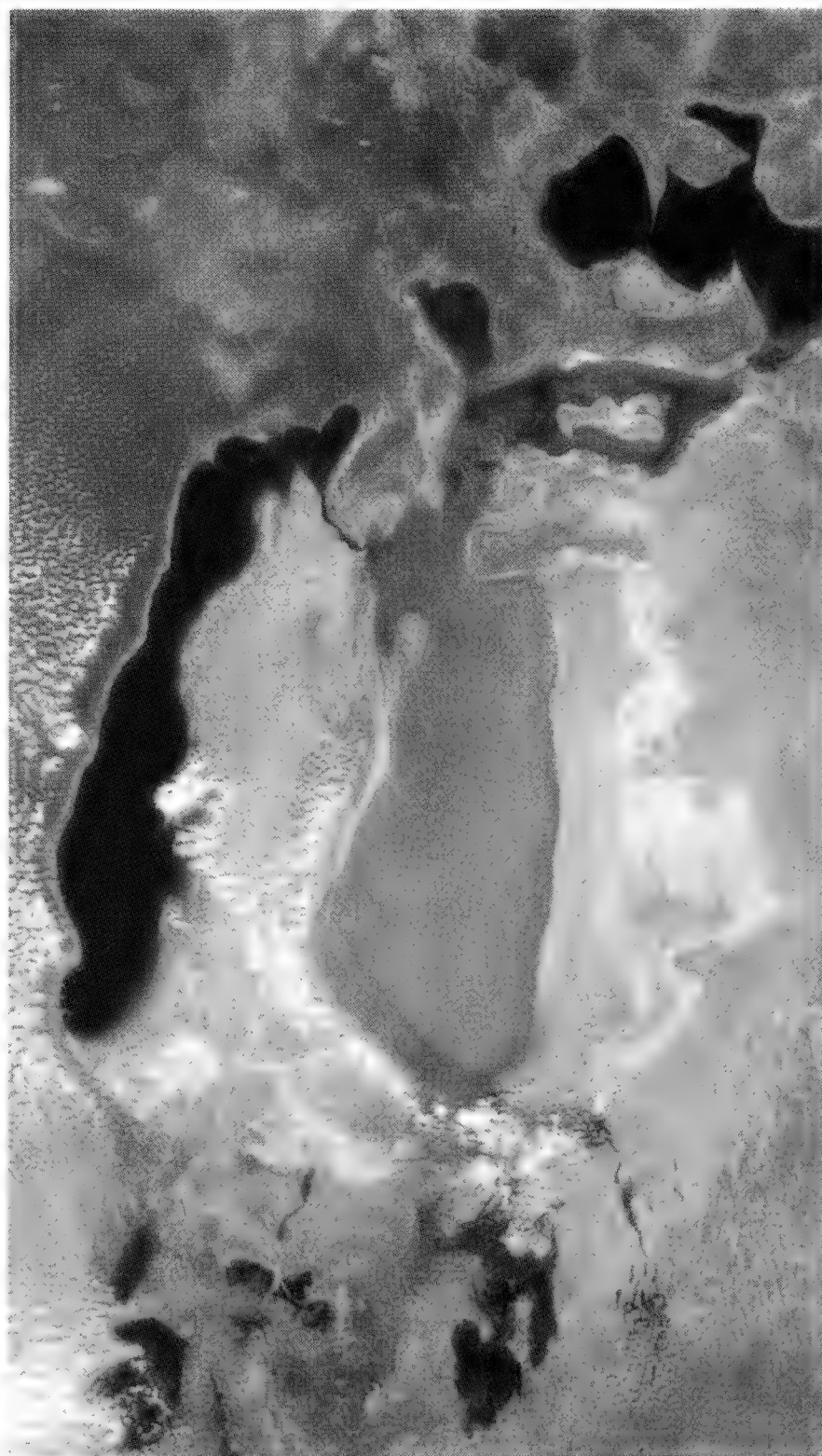
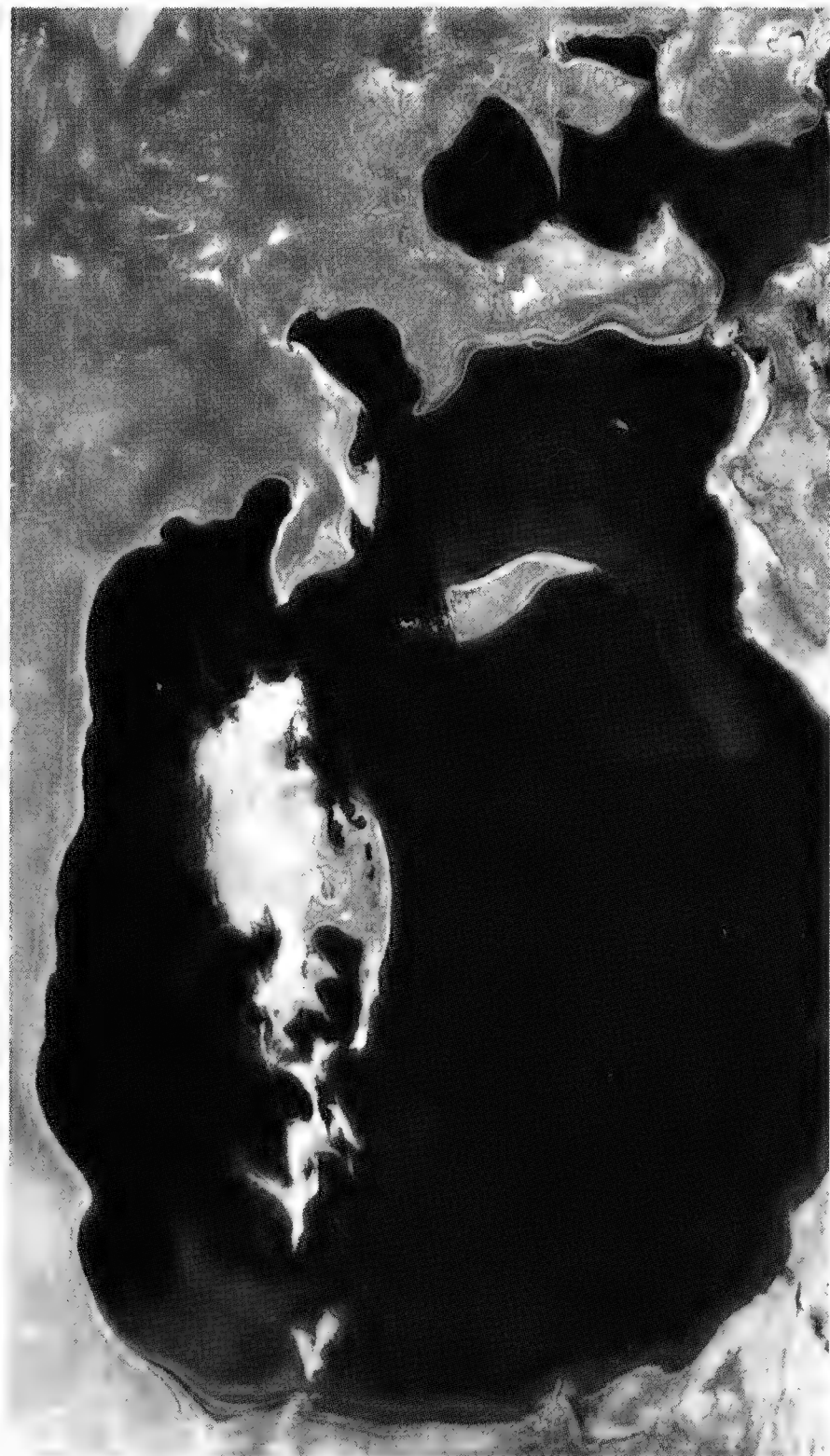
After the fall of the Soviet Union, local people in the north were free to take matters into their own hands, but with reduced water flows, they realized they could only save a portion of the sea. In 1992, they built a dam along an eight-mile channel that separates



**Rusting boats rest on the dry sands of what was once the Aral Sea.**

the northern sea from the much larger southern basin, which is shared with Uzbekistan. The project would keep water levels high in the northern Aral, but inevitably desiccate the southern basin, which most scientists felt was already doomed. Joop Stoutjesdijk, a water expert at the World Bank, says it was the only realistic option. “The southern sea is just too large, and there’s not enough water coming into the sea from the Amu Darya,” he says. “Even if you stopped all irrigation in Uzbekistan and Turkmenistan, it would still take 50 years to come back.” Unfortunately for the people in the north, their first barrier was too steep and soon eroded away. They immediately went to work on a second dam, but it failed during a storm in 1996.

**This series of satellite photographs shows, from left to right, the shrinking Aral Sea in 1989, 2003, and 2007.**







**Predators living near the Aral Sea, including the corsac fox (*Vulpes corsac*), may have declined as the sea's waters receded.**

Meanwhile, the World Bank had begun a series of preliminary studies related to water issues in Central Asia, with a particular interest in reviving the sea. In the 1990s, very little information was available locally for designing restoration efforts, because these areas had been so tightly controlled by Moscow. By 2003, however, the World Bank and the Kazak government were convinced that an Aral Sea restoration project could work and invested \$86 million to build a more permanent barrier to water flowing into the southern basin. Stoutjesdijk says that in order to prevent erosion, they designed this dam with a shallow slope that climbed a single vertical foot for every 50 horizontal feet. The influx of funding was also used to remove bottlenecks that were reducing flow along the rivers leading into the basin.

The World Bank originally estimated it would take two years for the water to rise to the top of the dam after it was completed in 2005, but water was pouring over the spillway in just 18 months. In the last two years, 11 species of freshwater fish have already returned to the lakes from river sources, and last year's catch was much larger than that of 2004. The water level has risen more than ten feet, and the area of the lake expanded by 50 percent. Last June, Stoutjesdijk brought his swimsuit. "We came prepared," he says.

Efforts to restore wetlands in the deltas of both the Amu Darya and Syr Darya rivers and on the dry lakebed itself are just beginning. Stoutjesdijk says that World Bank projects have helped recover an important forest and wetland around Uzbekistan's Lake Sudoche, one of the largest in the Amu Darya delta. "In Uzbekistan, we hope to look at a much smaller scale," he says. "Look at areas closer to the axis of the sea, to see whether there are important wetlands." The Syr Darya river, by contrast, is still a very wet region with wetlands stretching some 30 miles from the mouth of the river. How much terrestrial wildlife will return to the region is unknown, but the World Wildlife Fund has already reintroduced captive-bred Bukhara deer into nature reserves in Uzbekistan and Kazakhstan. The sea's water quality and the health of its fishery will ultimately depend on the health of the Syr Darya delta.

This is an exciting time for Nikolai Aladin, a zoologist at the Russian Academy of Sciences in St. Petersburg who boarded a train in September 2007 with a couple of plankton nets and a trunk full of scientific equipment. Although the Aral Sea is a relatively young water body and therefore never possessed a particularly unique fauna, it was replete with a microscopic menagerie including copepods, brine shrimp, and ostracods, which bury themselves in the upper layers of the sea floor. Aladin has watched numbers of these crustaceans gradually decline since his first visit to the Aral Sea as a student 30 years ago, and now he hopes to see them rebound.

Once a successful water management program is in place along the entire Aral Sea watershed, scientists like Aladin expect to see further signs of life. For example, sturgeon have cruised along the bottom of the sea for thousands of years, hunting crustaceans in the muck, but when the crustacean populations declined, the sturgeon did, too. Aladin says that, fortunately, invertebrate eggs settled to the bottom of the sea like "Sleeping Beauty," delaying their development during the harshest environmental conditions. As the water level rose again, the eggs began hatching one by one, the first step in rebuilding the depleted food web.

Despite these encouraging signs, no one is certain whether the Aral can ever completely recover. "We managed to bring catastrophe a little bit back, but other parts of the lake are still a disaster," warns Aladin.

## Illinois: Nutrient Farming

Returning water to the Iraq marshes and the Aral Sea brought immediate benefits to impoverished fishermen and subsistence farmers in those regions, but it may not be enough to guarantee long-term conservation. Some parts of the Iraq marshes, for example, will probably never be restored because they have become active sites for



oil drilling and exploration. In the U.S., the faltering economy has recently been blamed for derailing restoration efforts in the Florida Everglades, where developers are still paving over wildlife habitat and sugar producers have long fought strict pollution controls.

Although there are no guarantees when political forces are at work, in the last decade practical-minded ecologists have tried to place monetary values on the services provided by wetlands to make restoration efforts attractive in economic terms. Until recently, such estimates remained theoretical, but one project in the U.S. aims to develop a market of “nutrient credits” provided by restored wetlands along the Illinois River.

Each year, agricultural runoff and municipal waste-treatment plants spew tons of nitrogen and phosphorous into our rivers. This nutrient overload triggers algal blooms that suck up all the oxygen in water bodies and damage ecosystems. For example, fishermen don’t even bother going within 100 miles of the mouth of the Mississippi River in the Gulf of Mexico, where a massive algal bloom has created a dead zone that is mostly devoid of life.

In 2001, the Environmental Protection Agency announced that waste-treatment plants should reduce the nutrients they dump into waterways. Although there is no deadline in place yet, the agency has mandated that states develop water-quality standards for phosphorous and nitrogen. Large cities like Chicago can expect to spend several billion dollars upgrading their facilities.

Donald Hey, a civil engineer at the Illinois nonprofit The Wetlands Initiative, thinks waste-treatment plants should invest in restoring wetlands rather than making costly facility upgrades. “If we could restore a small fraction—let’s say six to eight percent of the wetlands—that we once had here,” says Hey, “we could relieve ourselves of huge flood damage losses. New Orleans, St. Louis, the upper Mississippi, the Sacramento, you name it. We could improve water quality dramatically and expand wildlife populations enormously.”

Hey has proven how easy it is to restore Illinois wetlands at a pair of lakes called Hennepin and Hopper. First settled in the 19th century by soldiers who received chits for fighting in the Civil War, the land around Hennepin and Hopper lakes became

aggregated over the years until only about seven or eight families controlled it. Around 1920, the families built a high levy around the property, drained the wetlands, and farmed the area until 2001. That’s when The Wetlands Initiative, along with The Nature Conservancy and other nonprofit organizations, arranged to purchase the property and restore it.

Workers combed the ponds and ditches on the property to eradicate several species of invasive fish that could inhibit recovery. Then, they turned off the pumps on the levy and let the marshes flood. Within a year’s time, waterfowl were returning to the region, and seeds that had been dormant for 200 years were sprouting up from the soil.

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**Within a year’s time, waterfowl were returning to the region, and seeds that had been dormant for 200 years were sprouting up from the soil.**

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The area is now teeming with soft-shelled turtles, migratory birds, muskrats, and beavers. By the first spring after the flooding, Doug Stotz, a conservation biologist at the Chicago Field Museum, noted 139 species at Hennepin including the pied-billed grebe (*Podilymbus podiceps*), bald eagle (*Haliaeetus leucocephalus*), and black tern (*Chlidonias niger*).

Hey’s effort is just one of many along the Illinois River that may one day serve as a model for the rest of the world. Current pressures on wetlands are only going to get more intense in the coming decades, and for these areas to survive conservationists are going to have to show that keeping the land intact is more valuable than destroying it. Z

—Brendan Borrell is a writer in Brooklyn, New York.

**Restored wetlands in Illinois are attracting muskrats (*Ondatra zibethica*) and other wildlife.**



John Cancalosi/naturepl.com





Of the six remaining tiger subspecies, the Amur tiger of the Russian Far East has the most “intact and extensive” habitat, according to a recent study.



# RUSSIA'S TOUGH TIGERS

by Howard Youth

Walk the streets of the bustling Russian Far East port city of Vladivostok and you will see them all over. On the city's coat of arms. On vodka bottle labels. On the logo of a local investment company called Tiger Securities. In September, visit the city's central square and you may stumble upon thousands of Russians celebrating International Tiger Day, a conservation-oriented event held there since 2000.

In this city, the striking, striped tiger is more than an eye-catching symbol. Vladivostok is the gateway to vast landscapes that shelter one of the world's most robust remaining tiger populations—that of the Amur, or Siberian, tiger (*Panthera tigris altaica*).

In the mid-1800s, when Vladivostok was founded as a city and Russian naval outpost, an estimated 100,000 tigers lived from eastern

Turkey to Java. Members of the world's largest cat species basically had the run of a vast and fairly continuous chunk of Asian forest habitat from India east through parts of China and north to coastal southeast Russia.

But 150-plus years later, the situation is very different. Of nine recognized tiger subspecies that once existed, just six remain. The last wild tigers of Bali (*P. t. balica*) vanished in the 1940s, the Caspian tiger (*P. t. virgata*) has been gone since the 1970s, and the Javan subspecies (*P. t. sondaica*) was proclaimed extinct in the 1980s. Today, no tigers survive west of India. Following years of unregulated and widespread shooting and trapping, overhunting of their prey, and habitat loss, the world's wild tiger population stands at fewer than 5,000 cats living in widely scattered, mostly small populations.





**Amur tigers share their habitat with boreal predators such as brown bears and wolves, as well as Amur leopards and other predators more typical to Asia. These animals and hundreds of bird species benefit from Amur tiger conservation efforts.**

In a July 2007 *BioScience* article entitled “The Fate of Wild Tigers,” a team of conservation biologists wrote: “Tigers now occupy seven percent of their historical range, and in the past decade the area occupied by tigers has decreased by as much as 41 percent, according to some estimates.” One of the authors is John Seidensticker, who heads the Smithsonian National Zoo’s Conservation Ecology Center and is chairman of the Save the Tiger Fund Council, an advisory body that approves grants administered by the Save the Tiger Fund. While it may seem that the world is becoming far too crowded for tigers, Seidensticker points to a silver lining. “There are bright spots,” he says, “and Russia is a bright spot for tigers.”

As the Amur tiger’s situation illustrates, there is always hope. But, although there are still wilderness areas that can support tigers, even Amur tigers cannot survive without the help of their human neighbors.

## Siberian No More

In school, in books, and in documentaries, we learn that lions live on African savannas and tigers live in Asian jungles. But, as they say, the devil is in the details. Not all lions reside in Africa; about 350 inhabit India’s Gir Forest. And while all tigers live in Asia, not all live in tropical rainforests. Like many other wild cats, the tiger is a habitat generalist, a predator with habitat preferences that defy generalization. Sumatran tigers (*P. t. sumatrae*), the smallest

tiger subspecies, live in lush, moist tropical rainforest, but Bengal tigers (*P. t. tigris*) often live in more open, seasonally dry forests interspersed with large grassy areas. And Amur tigers, the northernmost and among the largest tigers, live in temperate forests frequently blanketed in snow during winter months.

The Amur tiger was long known as the Siberian tiger, but that name was misleading. Siberia is a vast region east of the Ural Mountains, but tigers live farther east, in the lower part of a long coastal area called the Russian Far East. Russia’s tigers and the handful in neighboring China and perhaps North Korea are now called Amur tigers because they live in the Amur River basin. The *BioScience* authors call this area “the most intact and extensive tiger landscape in the species’ entire range.”

Like all tigers, the Amur tiger is solitary and territorial. It wanders through habitats ranging from lowlands to mountain forests of Korean pine (*Pinus koraiensis*) and Mongolian oak (*Quercus mongolica*), which provide a bounty of fallen pine cones and acorns that fatten red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*), the Amur tiger’s primary prey. Biologists call the tiger a keystone species because it has a strong influence on other animals and plants in its ecosystem, especially deer and boar. From a conservation perspective, it is also called an umbrella species because when its ecological needs are met, so are those of myriad other living things that share its landscapes.

Amur tigers live with wildlife from boreal forests and from other parts of Asia, says Wildlife Conservation Society biologist Dale



Miquelle, who lives in Russia and has been studying tigers there for 15 years. “Nowhere else in the world do tigers need to defend their kills from boreal predators such as wolves, brown bears, wolverines, and lynx, while at the same time coexisting with carnivores more common to Asia, such as the leopard and Himalayan black bear.” All of these mammals and many others benefit from the protection of Amur tiger habitat, as do hundreds of bird species.

Within the Amur River basin, 95 percent of tigers inhabit the Sikhote-Alin mountain range, which runs north-south for about 620 miles at latitudes similar to those between northern California and Vancouver. The mountains rise from sea level and most peaks are no higher than 4,000 feet. “The mountain range is rather narrow valleys with pretty steep ridges,” says Seidensticker. “It kind of reminds you of ridge-and-valley Appalachia, but the forest type is more like Vermont.”

Inside the Sikhote-Alin range, Amur tigers enjoy a fairly contiguous forest habitat containing the Sikhote-Alin Zapovednik—Russia’s largest protected area for tigers—and two new national parks. Outside the Sikhote-Alin range, however, Amur tigers live in much more fragmented habitat. Settlements and farmland block tigers from encountering others of their kind, leading to limited mate choices and potentially compromised genetic variability. The most isolated areas sit just west of Vladivostok along Russia’s borders with China and North Korea. There, perhaps ten to 15 Amur tigers survive, as well as the critically endangered Amur leopard (*P. pardus orientalis*).

From these patchy border habitats, some Amur tigers move into large forest tracts in northeast China, and possibly even into North Korea. Such border crossing makes recovery of tigers in these countries possible, despite the fact that illegal trade in tiger bones and body parts for traditional Chinese medicine is one of the primary threats to the species’ existence across Asia.

## Recovery, One Striped Cat at a Time

Despite its extensive wilderness, the Russian Far East almost lost its tigers halfway through the 20th century. They survive today thanks to Russian scientists’ and the Russian government’s efforts, in collaboration with international organizations, to study and restore their populations. In the late 1800s, more than 1,000 tigers likely inhabited the region’s mountain forests, foothills, and lowlands. The population declined sharply from the early 1900s through the 1930s, as more Russians moved into the area. As happened in the U.S. West, many well-armed settlers shot at any large animal they came across. While much of the hunting of deer and boar was for subsistence, many people hunted these animals as well as tigers and leopards for sport, a tradition that continues today. Fear also led to the killing of tigers.

In 1940, Lev Kaplanov, a young Russian biologist who was killed three years later by poachers, led the first intensive survey of Amur tigers, which concluded that only 20 to 30 Amur tigers remained. The Russian government finally responded in 1947, banning tiger hunting and limiting the number of cubs that could be captured by animal traders. Research, including tracking and census work, has continued ever since.

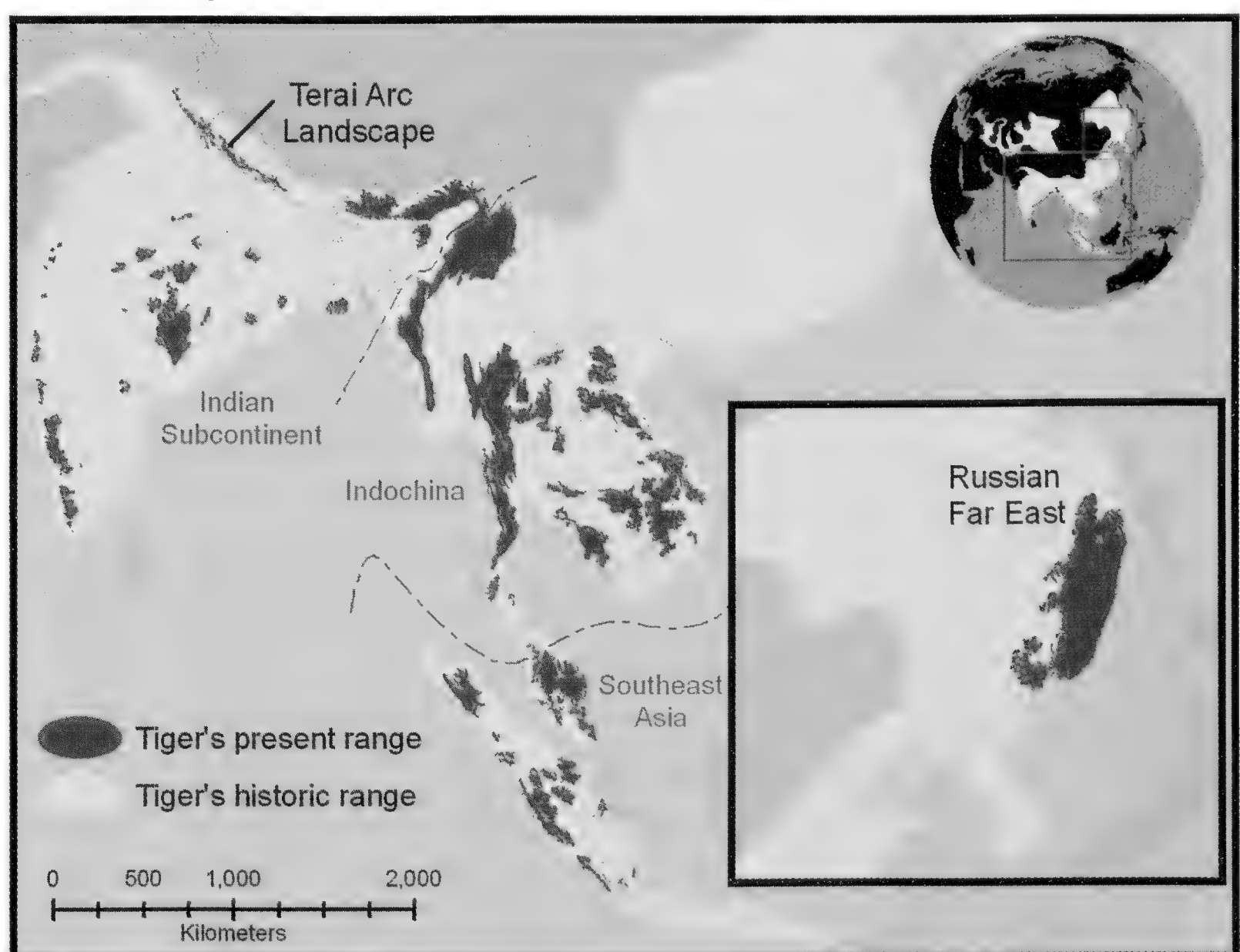
The tiger population started to grow immediately, albeit slowly. By 1990, there may have been more than 500 individuals as tigers once again spread out in the forests of the southern Russian Far East.

But poaching increased after the fall of the Soviet Union in 1991, due to the loosening of regulations and people’s economic desperation. Between 1992 and 1994, an estimated 40 to 60 tigers were trapped or shot each year, their bones and skins taken to China for sale.

In 1995, then-Russian Prime Minister Viktor Chernomyrdin signed a decree calling for the development of a national strategy for tiger conservation. Anti-poaching efforts and education programs increased, thanks in good part to assistance from Russian and overseas nongovernmental organizations (NGOs), as well as governmental agencies from other countries. Also in 1995, Miquelle and his colleagues led an extensive survey of tiger habitat, funded in part by the U. S. Agency for International Development (USAID). The survey estimated the country’s tiger population at between 430 and 470 animals.

In a habitat protection plan presented in the 1999 book *Riding the Tiger: Tiger Conservation in Human-dominated Landscapes*, Miquelle and his colleagues wrote that about 60,000 square miles—an area larger than that of nearby North Korea—remained as tiger habitat in the Russian Far East. The authors wrote: “We defined the goal of this habitat protection plan as protection

**This map shows how dramatically the tiger’s range has shrunk, particularly in the last 150 years. The inset shows historic and present Amur tiger habitat.**



Save the Tiger Fund



of all existing tiger habitat, i.e. no further loss of Amur tiger habitat should occur.”

Miquelle and his colleagues concluded that only seven percent of remaining tiger habitat fell within declared reserves and wildlife refuges and that “even under the most optimistic habitat protection plan, no more than 16 percent of tiger habitat would be strictly protected.” Nonetheless, this plan stimulated efforts to create a protected areas network, which was eventually brought into existence via support from the Save the Tiger Fund and a large grant from the Global Environmental Fund. Today, the percentage of protected tiger land may be up to ten or 12 percent, although no recent calculations are available.

So far, the new century has dawned with a healthy Amur tiger population with bright prospects. A 2005 tiger survey yielded an estimate of between 430 and 502 individuals, the good news being that even if numbers hadn’t increased much in the ten years since the last census, they hadn’t declined as they have almost everywhere else in the tiger’s range. And in 2007, important steps were taken to secure two key areas: The Russian government created the 315-square-mile Zov Tigra (“Roar of the Tiger”) National Park and the 245-square-mile Udege Legend National Park. These parks had been in the works for well over a decade. Both will protect Amur tiger habitat while fostering a growing ecotourism industry.

And there are signs that tiger numbers are increasing in nearby China, where some protection measures are going into place. In 2001, the Chinese government created the Hunchun Tiger-Leopard Reserve, protecting a sliver of habitat along the Russian border as a “beachhead” for tigers and leopards dispersing from Russia.

Miquelle and other conservationists believe that managing tigers outside of declared protected areas must be a priority. To do so, important tiger core areas need to be stitched together via designated wildlife corridors and large swaths of land used not only for conservation but also for compatible forestry and other activities. “Carving out additional large tracts of land specifically to protect tigers is unlikely in the present economic boom times of Russia. Therefore, it is essential that ways be found to mix tiger conservation and wise use of forest lands for sustenance of the local people,” says Miquelle.

In Russia, funds for conservation programs are often very limited, but conservationists there have received strong support from overseas NGOs, including the Save the Tiger Fund, the World Wildlife Fund (WWF), and the Wildlife Conservation Society, as well as from agencies of other governments, including USAID and the U.S. Department of the Interior. Between 1998 and 2002, according to the *BioScience* article, NGOs spent, on average, a total of more than \$1.5 million

Tom and Pat Leeson



**Half of all Amur tiger cubs die before they turn one.**

each year on Amur tiger conservation efforts, which included park management, anti-poaching efforts, law enforcement, training for Russian staff, and education programs.

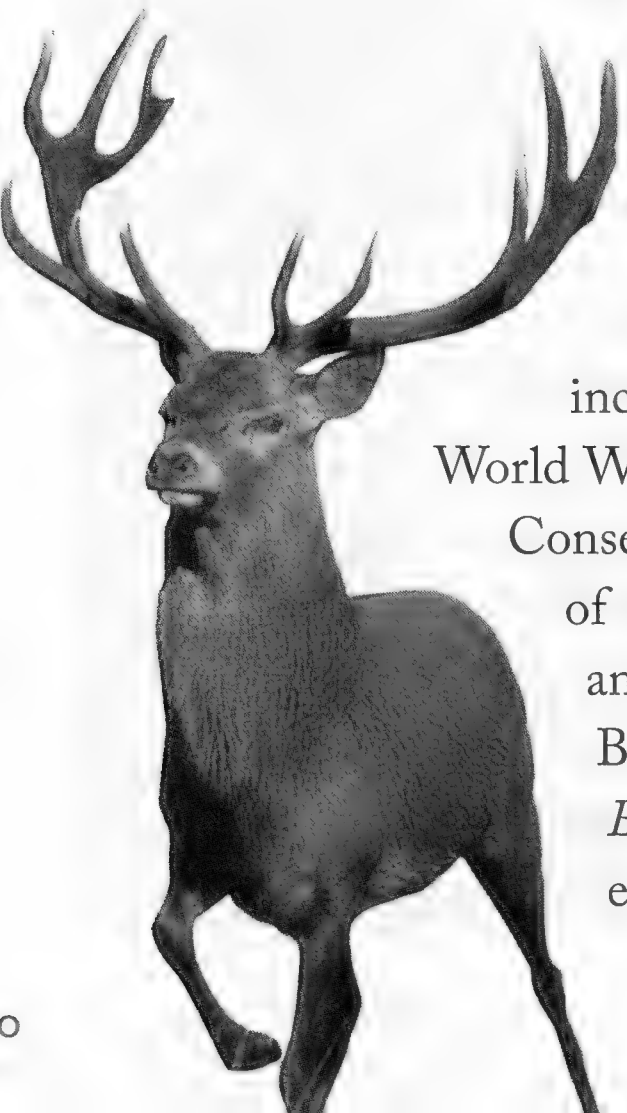
Anti-poaching patrols have helped reduce illegal hunting, although humans continue to be tigers’ main threat to survival. Miquelle and his colleagues have radiocollared and monitored more than 50 Amur tigers since 1992. This work helped them piece together one of the clearest pictures of how these tigers live, including details on Amur tiger social structure, land use, diet, reproduction, and causes of mortality. They found out, for example, that more than 80 percent of tiger mortality in Russia comes at the hands of humans, and that while tigers produce on average 2.4 cubs every 21 months, half die before reaching one year old. Many cubs die because poachers kill their mothers.

This monitoring work also provides a sobering picture of just how many tigers fit into the landscape. All adult tigers are territorial, and there is little overlap between females’ home ranges. A resident female Amur tiger requires about 155 square miles to successfully raise cubs, so the roughly 1,545 square-mile Sikhote-Alin Zapovednik—the size of Rhode Island—harbors just ten tigresses. The home range of a male usually overlaps that of one to several females and is about three times as large—about 465 square miles—and six to nine males have been reported in Sikhote-Alin Zapovednik in the past few years, but they’re probably not all resident males.

## Hunters and the Hunted

Red deer and wild boar provide up to 85 percent of the Amur tiger’s diet, so the welfare of these ungulates is a life-or-death matter for the cats. Deer and wild boar also are the favored prey of hunters, who have contributed to recent sharp dips in their populations. Many hunters, however, blame the Amur tiger when prey becomes scarce. “It is the top obligate predator in the Russian Far East,” says Seidensticker, “and if you ask a Russian hunter, he’ll say the tiger is taking away his food.” But tigers and hunters can coexist, as long as conservationists and hunters work together to boost the local prey numbers.

**Red deer are among Amur tigers’ and hunters’ favorite prey.**





Miquelle is working with managers of hunting leases to increase their capacity to manage wildlife and especially to increase prey numbers. Says Miquelle: “Our rationale is that, although hunters view tigers as competitors, if we can help them increase prey numbers, it is a win-win situation—hunters have more opportunities to harvest ungulates for food, and tigers do, too.” Measures include improving wildlife habitats to provide more forage and augmenting food during times of scarcity, such as hard winters. The WWF has also worked with about 20 hunting estates on its Ungulate Recovery Program, with noted increases in prey species.

Deer, boar, and tigers, however, may face further challenges from changing climate. In recent years, climatologists noted an increase in the frequency of El Niño events, driven by changes in sea-surface temperatures in the equatorial Pacific that profoundly alter weather in many areas of the world. El Niño events used to occur about once a decade, but now pop up about once every five to seven years. Among other things, these sea-temperature changes apparently affect the southern monsoon, which provides seasonal moisture critical to habitats and agriculture across much of southern Asia. And the southern monsoon’s effects can be felt as far north as Amur forests.

Since 2003, University of Maryland faculty research assistant and National Aeronautics and Space Administration fellow Tatiana Loboda has been studying these meteorological phenomena and how they might affect the frequency and intensity of fires in Amur tiger habitat. “There is some indication that summer fires are somehow connected with the Southeast Asian monsoon and possibly El Niño,” says Loboda.

Some coniferous trees, such as the longleaf pine (*Pinus palustris*) of the U.S. Southeast, are fire dependent—flames help propagate their seeds while clearing out competing trees. Not so in the Amur region, where fire wipes out spruce, fir, and larch. But for tigers, such burns may not be all bad.

“Summer fires are rare, but when they occur, they are generally very large and very intense,” says Loboda. These conflagrations kill almost all plants in their path. When they scorch spruce, fir, and larch, fires clear the way for slow regrowth of different vegetation, including Mongolian oak and other broad-leaved trees that provide a better food source for deer and boar and better tiger habitat.

But Loboda’s modeling work indicates that fire frequency may increase with projected climate shifts, a situation that could undo any long-term benefits of sporadic, fire-wrought forest change. “If climate change occurs,” says Loboda, “these positive long-term benefits are likely to be taken away, because fires might be much more frequent...and will counterbalance any benefit in terms of long-term vegetation recovery.”

Fire also destroys Korean pine, a valued tree that is already becoming rare due to overharvesting. Even where mature trees still stand, pine nuts have become scarce because local people collect these edible seeds and sell them to Chinese and Korean merchants. While this brings in much-needed income, intensive gathering eliminates nuts that provide vital winter nutrition for wild boar, deer, and bear.

Deer- and boar-hunting, mushroom- and plant-collecting, and selective logging are all extractive forest uses that can be compatible with tiger conservation. But one of forestry’s by-products is detrimental to tigers: “For tigers, roads are ecological traps,” says Seidensticker. Once carved into forests, roads open areas to people other than foresters. “I consider [the road issue] one of the most important issues out here,” says Miquelle. “As more and more logging roads

are built, they provide greater and greater access for both legal and illegal hunting, increased risk of fire, and have lots of additional impacts.” Miquelle hopes that soon he and his colleagues will work with logging concessions to close forest roads after trees have been extracted.

For now, though, much of the Amur region remains a frontier where large tracts of wilderness remain. It is a place where tigers can, by and large, live outside the influence of humanity, where they can hunt, find mates, and raise their young with a reasonable chance that they will avoid stepping into the crosshairs of poachers’ gun sights. “Russia is one of the only places where tigers haven’t recently been in decline,” says Seidensticker. “But we’re at a stalemate. Things are okay. But things could change.” Z

—Contributing editor Howard Youth’s recent ZooGoer articles have included features on Florida panthers, birds and insects, and prairie grouse.



**Climate change could counteract the benefits of naturally occurring forest fires for Amur tigers in the Russian Far East.**



A llama stands in front of jagged, snow-capped mountains. Llamas and alpacas are the South American relatives of camels and guanacos. Their ancestors likely helped to build Ulaqta, among many ancient ruins in the region.







# Discovering South America's camels

by Mary-Russell Roberson

**I**n 1951, Carl B. Koford of the Museum of Vertebrate Zoology at the University of California, Berkeley, was the first to study a mammal called the vicuña in its high-elevation habitat. Camping at 15,500 feet—three miles above sea level—in the Peruvian Andes, Koford described his first glimpse of vicuñas in a 1957 *Ecological Monographs*:

*High in the central Andes of western South America, above the limit of cultivated crops, lies a treeless pastoral zone, the puna. While scanning the bleak rolling grasslands...a traveler may be startled by a prolonged screech. The cry attracts his gaze to a racing troop of fifty gazelle-like mammals, bright cinnamon in color—vicuñas! ...[The animals are fleeing] the approaching llamas and the somber Indian who trudges behind them. ...the vicuña is reputed to spend its life at heights reached only by the lofty peaks in his own country, and...it bears a costly fleece which, centuries ago, clothed Inca royalty. To him the vicuña resembles, in size, actions, and habitat, the pronghorn antelope of the Great Plains. But inasmuch as the vicuña has a long neck and rather large head, and lacks horns, it is more like a small humpless camel.*

Koford evocatively captured the essence of the vicuña's story: its habitat, size, group-living, its value to people, its adaptations—Incredibly, it was *running* in the thin air of that altitude! And its place in the pantheon of mammals. Like its three South American cousins, the wild guanaco and domestic llamas and alpacas, the vicuña is, indeed, a sort of camel.





All members of the Camelidae family, including llamas, have two-toed feet.

## Camels Move On

What most people think of as camels—dromedaries and Bactrians—are so firmly associated with the deserts of Africa and Asia that it is hard to believe they have close relatives in South America. Camelids originated in North America 40 to 45 million years ago, then evolved on the continent's grasslands into a diverse array of forms, including the gazelle-like *Stenomylus*, the giraffe-like *Aepyamelus*, and the nearly 12-foot-tall *Titanotylopus*, which resembled today's Old World camels. William Franklin, professor emeritus at Iowa State University in Ames, says, "At one time, there were probably several dozen genera of camelids in North America. In some areas, they were surely the dominant large herbivores." Then, six to three million years ago, opportunities for leaving their homeland arose when the Earth's climate cooled and sea levels fell, exposing land bridges to the south between Panama and South America, and to the north across the Bering Strait between Alaska and Asia.

Those that migrated north, from a "tribe" of camels called the Camelini, spread across Eurasia and eventually evolved into several species including the dromedaries and Bactrians we know today. The Lamini tribe went south and evolved into, among others, the vicuñas and guanacos of South America, and most recently their domestic forms, alpacas and llamas.

The camelids remaining in North America persisted until near the end of the Pleistocene epoch between 10,000 and 15,000 years ago, when like so many other large mammals they went extinct due to human overhunting, climate change, introduced diseases, or some combination of these factors. Except for the vicuña (*Vicugna vicugna*) and guanaco (*Lama glama*), South American camelids went extinct about the same time. Some Eurasian camel species may have survived a bit longer, but today only domestic dromedaries, domestic Bactrians, and a handful of wild Bactrians (*Camelus bactrianus*) remain.

Even though the Old World Camelini and New World Lamini diverged about 11 million years ago, many similarities remain. All of the camelids are herbivores living in open habitats from savanna grassland to desert, and their split upper lip helps them grasp and tear off bits of grass or leaves. They also possess long necks, slender heads, long eyelashes, padded feet with two toes, and the ability to get by without much water. They can "kneel" on their hind legs when they sit down, unlike cows and horses.

All camelids also have a three-chambered stomach. Food goes to the first stomach chamber where it is partially digested, then regurgitated—in other words, camelids "chew the cud" just as cows do. The cud is swallowed and moves through the next two chambers to be fully digested. This complex digestive system ekes out as much energy as possible from diets that are mostly grass.

When defending themselves or fighting for dominance, camelids spit the contents of their mouth or a foul-smelling fluid from the first chamber of their stomach. Another behavior all camelids share is their curious walking gait, whereby their legs on each side move in unison rather than alternating, as do those of most other four-legged mammals.

There are differences too, the most obvious being that South American camelids have no humps, and are much smaller than Old World camels. While dromedaries and Bactrians weigh in at 1,000 pounds, the heaviest South American camelid, the domestic llama, weighs only about 185 to 300 pounds.



South American camelids also have adaptations that allow them to thrive at high elevations. Their thick wool coats keep them warm, and their extra-large hearts and lungs keep their bodies well-supplied with oxygen in the thin air. And, although they're tremendously useful to people, New World camelids are not nearly so famous as their Old World counterparts.

## The Wild Ones

For all their similarities, vicuñas and guanacos—the wild South American camelids—are a study of contrasts. Vicuñas weigh between 80 and 110 pounds and live on windswept, cold, semi-arid plains called puna between about 10,000 and 16,000 feet. They inhabit the Andes in central Peru, western Bolivia, northwestern Argentina, and northern Chile. Guanacos are larger, between 185 and 300 pounds, and are more widely distributed. They live from sea level to 13,000 feet in a wide variety of open habitat in and around the Andes, from northern Peru all the way to the southern tip of South America. The vast majority of guanacos live in a region called Patagonia in southern Chile and Argentina.

The two species' ranges do not overlap much, but where they do, the animals choose slightly different habitats. Vicuñas are more restricted in their diet, eating primarily grass and some small forbs and lichens, whereas guanacos eat shrubby vegetation as well. Vicuñas must drink water daily, especially during the dry season; guanacos can go for long periods without drinking water.

Franklin has studied South American camelids for 40 years, beginning with a four-year study of vicuñas in the early 1970s, then studied guanacos as well to compare their ecology and social behavior.

Franklin found that vicuñas live in family groups composed of a male, several females, and their young. When the young near maturity, the male forces them out of the group. Unless they're defending a territory alone while attempting to attract females, bachelors form all-male herds while females try to join existing family groups. The vicuñas do not migrate seasonally. Instead, family groups live on permanent, year-round territories that the male defends from all intruders. Although some territories are better than others, each contains sufficient forage to support the group all year. The best territories also have a permanent source of water. Habitat with good forage is found in scattered patches between bare ground and other unsuitable habitat.

Seasonally, territories are also used for mating and breeding. A male defends his females from the attentions of other males, and actively prevents his adult females from leaving. Unusual among mammals, a male limits the number of females that live on his territory—the average is three—

probably to ensure there is enough food to go around. Over time, the size of the group on a territory is fairly constant. "Females most likely pick males for real estate, not for good looks," Franklin says. "But the male more often than not rejects outside females. There is a relationship between the number of animals in a group and the amount of the forage in that territory. Who knows how the male assesses what is going on?"

Franklin also discovered that vicuña groups actually use two territories—one for daytime foraging, and a smaller one at a slightly higher elevation for nighttime sleeping, which perhaps offers greater safety from predators. Males mark their territories with dung piles that females and young also use. The piles act as fertilizer,

and where the dung piles are on steep slopes, the dung falls downhill and produces strips of relatively lush vegetation.

Guanacos' social system differs from that of vicuñas' in being far more variable and flexible, as is their habitat and

feeding ecology. Some guanacos live in sedentary family groups on year-round territories. Others have only seasonal breeding territories and migrate when forage is covered in snow or dries up. Group size varies over the year and females move in and out of the group freely; sometimes females form their own all-female groups. Very large mixed herds of both sexes are also seen in migratory populations. Territorial males drive out their young, but not until they are older than vicuñas are when they are expelled. Guanacos appear not to have separate nighttime territories.

In both species, females give birth to a single offspring each year. As with many ungulates, the young can walk just a few minutes after birth. In fact, Franklin notes that if researchers want to tag infant vicuñas, they must do so within the first 15 minutes after their birth—vicuñas older than that can easily outrun a human.

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**In both species, females give birth to a single offspring each year. As with many ungulates, the young can walk just a few minutes after birth.**

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**A herd of guanacos in Torres del Paine National Park, Patagonia, Chile.**



David Mathies / iStockphoto.com





In Bolivia and other parts of their range, wild vicuñas are rounded up and sheared of their fine coats, then released.

## The Domestics

Archeologists have documented vicuñas' and guanacos' path to domestication, which is believed to have originated in the puna ecosystems of Peru, based on changes in the composition of animal remains in sites of long-time human occupation. People first appeared on the puna about 12,000 years ago, and for next several thousand years they preyed heavily on nearly equal numbers of the two camelids and the taruca (*Hippocamelus antisensis*), a deer about the size of a vicuña that occupied roughly the same range. Over time, people gradually shifted away from hunting deer toward a specialized hunting of camelids, then to controlling early domestics perhaps by corralling them. Then, about 5,500 years ago, people managed to fully domesticate camelids as part of a herding economy. Llamas and alpacas spread from here and may also have been domesticated independently elsewhere in their range.

People hunted camelids for meat for thousands of years—and still do—and this was mostly likely the impetus for their domestication, according to Katherine Moore, a research associate at the University of Pennsylvania Museum of Archaeology and Anthropology in Philadelphia who specializes in the archaeol-

ogy of domesticated animals, especially llamas and alpacas. She says, "The human need for food has always been greater than the human need for pelts and wool." Much later—perhaps 1,000 or 2,000 years after the initial domestication—secondary uses of the animals would have been exploited, such as wool and transportation. Moore points out that the exploitation of secondary resources from domestic animals often takes quite awhile. Cows, for instance, were domesticated about 10,000 years ago, but weren't milked until about 5,000 years ago.

Llamas were domesticated from guanacos, a long-established fact undisputed by scientists. "Genetically, they are very similar animals," Franklin says. "There are some differences in color and body size and so forth, but it's pretty clear the guanaco was the wild progenitor of the domesticated llama." It is also clear that, apart from their use as food, people bred llamas as pack animals and for their wool.

Alpacas, which are bred exclusively for wool, have a more complex background that has confounded scientists. For many years, the accepted wisdom based largely on morphology was that alpacas were also domesticated from guanacos, although there were dissenters who argued for a vicuña ancestor, a hybrid guanaco-vicuña ancestor, or a hybrid llama-vicuña ancestor.

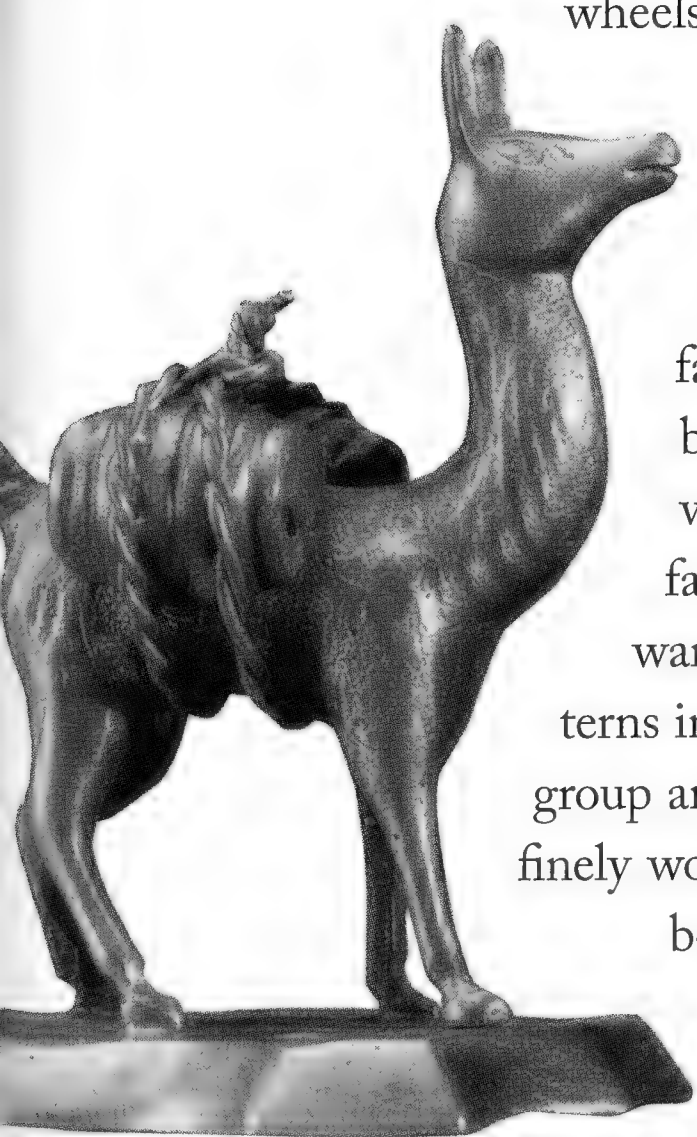
Recent DNA analyses by Miranda Kadwell of the Institute of Zoology in London and her colleagues, reported in 2001 in the *Proceedings of the Royal Society of London B*, yielded seemingly contradictory results: Although analysis of some DNA strongly indicates that alpacas are domesticated vicuñas, almost all of the alpacas from which samples were obtained have a substantial amount of llama and/or guanaco DNA. Still, the now-prevailing view is that alpacas originated from vicuñas, and their current mixed genome is the result of more-or-less recent hybridization among domestics.

Whatever the origins of domestic camelids, which were the only mammals the Andean people domesticated except for the guinea pig (*Cavia porcellus*), the Andeans were skilled breeders. Moore says that there were likely more domesticated forms than the two that exist now. Archaeologists have found evidence of a larger llama-type animal that was probably used in trade caravans, and small and large alpaca-like animals.

About 15 years ago, archaeologists found some 1,000-year-old alpaca and llama "mummies" in southern Peru. The animals had all been killed with a blow to the head, buried under a house, and left there, perhaps in a religious ceremony. Camelid expert Jane Wheeler, who was then a visiting professor at San Marcos University in Lima, examined the fiber of these animals, which was well-preserved thanks to the extremely dry climate. She was surprised to discover that it was much finer than that of current-day alpacas and llamas. "Finer" translates into "softer" when the fiber is spun into yarn.

Modern-day llamas and alpacas have fiber that is in the range of 20 to 40 micrometers in diameter, with alpaca being at the fine end





A silver llama figure made by the Aymara people of Bolivia.

of the range and llama fiber being at the coarse end. The mummified llama fiber was 22.2 micrometers, and the mummified alpaca fiber was 17.9 micrometers. The mummified animals also carried more fiber at a younger age than modern llamas and alpacas.

The mummies predate the rise of the Inca, indicating that pre-Incan people were already managing the breeding of their alpacas and llamas with the goal of producing fine fiber. This knowledge was lost, however, with the collapse of the Inca Empire at the hands of the Spanish conquistadors.

There is also evidence of differential management of llamas and alpacas. Writing in the *Journal of Archaeological Science* in 2006, Brian Finucane of the University of Oxford in England and his colleagues suggest that pre-Columbian pastoralists raised alpacas (but not llamas) in the high-elevation puna because cold promotes the growth of their prized fleece. In contrast, camelids at lower elevations, probably mostly llamas, were corralled and fed the maize stalks and husks that remained after crops were harvested. This practice, too, was lost and now alpaca and llama are raised together in the puna while sheep and other non-native livestock occupy lower ground.

## Empire Building

Llamas and alpacas are inextricably intertwined with the rise and spread of the Inca Empire, which began to grow in the Peruvian Andes about 1200 C.E. The Inca built beautiful and sturdy walls, buildings, and towns of interlocking stone. They built irrigation systems to keep entire valleys green in the arid environment. And they built 14,000 miles of roads that crisscrossed the empire and eventually extended about 3,400 miles, from Ecuador south to central Chile and parts of Argentina.

Llamas and alpacas were with them every step of the way. Llamas carried materials for building roads, temples, and irrigation canals; baskets of gold and silver out of mines; and cargo for trade. These surefooted animals with padded feet transported whatever needed moving in a society that never invented wheels, perhaps because

wheels were far less effective in steep rocky terrain than animals adapted to walking on such rough ground.

Alpacas were prized for their fine and fluffy wool, from which the Inca fashioned tunics, tapestries, twine, rope, and bags. Men wore wool tunics and women wrapped themselves in larger pieces of wool fabric. But clothes were not just for keeping warm in the cold mountain air. Detailed patterns in a variety of colors spelled out the ethnic group and class of the wearer. Leaders exchanged finely woven clothes to keep the peace. The most beautiful articles of wool clothing were used to dress religious figurines that were burned as offerings to the gods.



Yarn made from alpaca and llama fiber in Peru.

Moore says, “We know that cloth and stuff made out of cloth has been very important in the Andes over the years as trade and exchange items, and as a way of showing the symbols of the world you belong to, your beliefs, your rank in society. The earliest cloth we have is already studded with messages.” Today, people of the Andes continue to produce colorful and intricately patterned ponchos and hats from the wool of alpacas and llamas.

Alpacas and llamas also supported the Inca Empire with meat, leather, fat for food and candles, pelts for blankets, and dung for fuel. Dried llama or alpaca meat was called *charqui*, a word that later became “jerky” in English. The Inca stored vast quantities of jerky and similarly dried fish and plants along royal highways to fortify traders and soldiers on long journeys through the empire.

Llama and alpaca wool was also used to make knotted records called *quipu*. The Inca did not develop a system of writing, but they kept track of immense quantities of food, textiles, precious metals, and people by making knots in colored twine. The importance of llamas and alpacas to the Inca culture is further illustrated by the fact that they were frequently depicted in art such as ceremonial bowls, pitchers, tapestries, and figurines made of silver and gold. Some of the art shows llamas being used in ritual sacrifice.

Their importance is also suggested by European accounts of the size of their herds. Cornell University anthropologist John V. Murra wrote, “It is difficult to imagine the size and pan-Andean distribution of herds. In the early decades after the invasion, European observers were stunned by the omnipresence of the beasts...” Murra goes on to say one European reported that “he had heard of an Indian who is not even a lord just a local personage...who had more than 50,000 head of stock.”

The invasion Murra mentions, of course, is that of conquistador Francisco Pizarro and his small army of Spaniards. In 1532 C.E., they captured Atahualpa, the leader of the Inca, in the city of Cuzco in what is now Peru. Pizarro demanded and received a room full of gold and two rooms full of silver for the release of Atahualpa, then executed him anyway. The Inca Empire, already weakened from the onslaught of European diseases, crumbled.





An alpaca farmer tends his herd at the base of the Cotopaxi Volcano in central Ecuador.

## After the Fall

The social disarray that followed the European conquest of the Inca Empire led to the loss of old breeds. Herds of domestic camelids were decimated as European sheep, goats, cattle, and pigs replaced them on pastureland, and they nearly disappeared by the end of the 1500s. Wild camelids fared even worse.

Scientists estimate the pre-Columbian population of guanacos at 30 to 35 million and that of vicuñas at perhaps several million. In the centuries following the fall of the Inca Empire, overhunting in combination with competition for pastureland from introduced livestock greatly reduced the numbers of guanacos and nearly wiped out vicuñas. By the 1960s, only about 10,000 vicuñas remained. Today, the population has rebounded to several hundred thousand. Guanacos number around 0.5 million, but they occupy less than half of their former range.

Populations of guanacos and vicuñas have stabilized and grown in recent years due to some fairly standard methods—setting aside protected areas and enforcing laws against illegal hunting. A more unusual conservation technique has helped boost the numbers of vicuñas: shearing wild animals and releasing them alive. The ability to legally live-shear the animals reduces people's incentive to hunt them for their fleece, and shorn vicuñas have no value to a poacher.

Vicuñas have one of the finest fibers in the world, at a diameter of 12 micrometers. (The fiber of cashmere goats is 14 to 19 micrometers, and that of shahtoosh from the Tibetan antelope, or chiru, is from nine to 12 micrometers.) "It's hard to exaggerate the silkiness of vicuña fiber," Moore says. "When you rub a tuft in your fingers, you can see it but you can't feel it, it is so fine." It is so sought-after that in 2004 a kilogram (2.2 pounds) could be sold for \$566 wholesale. One ounce of certified live-sheared vicuña fiber retails for \$250 in the United States.

According to some reports, the Inca (and perhaps others before them) periodically rounded up thousands of vicuñas, at two- to

three-year intervals, in massive efforts involving as many as 30,000 people. Some vicuñas were killed immediately for meat and leather, but most were shorn of their precious wool and set free. The time between roundups was dictated by the time it took the vicuñas to regrow their fleece to a length of one to two inches.

In 1995, to promote both conservation and local economic development, the government of Peru began encouraging its citizens to conduct similar vicuña roundups. Villagers on foot herd vicuñas into a net-lined chute that leads to a small corral, where the vicuñas are inspected and

sheared. The fiber of sheared vicuñas grows back completely in two or three years. If the vicuñas' fleece is not long enough or they are youngsters then they are let go.

A study done in Peru and published in *Conservation Biology* in February of 2007 looked at females shorn in the spring, and found no increase in mortality of the females or decrease in number of young they produced compared to unshorn females. But more research must be done to determine if the same can be said of vicuñas shorn in cold weather.

In some places in Peru, vicuñas are living permanently inside large corrals (on the order of 2,500 acres) to facilitate roundups. However, while corralling makes live-shearing easier, some scientists are concerned that it may interfere with natural gene flow between corralled and uncorralled populations, or that being corralled will set the vicuñas on the path to domesticating themselves.

Live-shearing guanacos is not a widespread practice, but some people think it should be. Guanaco fiber is nearly as fine as vicuñas'. In the wild, the animals are threatened by poaching and by competition from sheep, which graze on similar plants. A study published in the *Journal of Arid Environments* in 2006 demonstrated a successful process for capturing and live-shearing wild guanacos in Patagonia. The authors propose that a live-shearing program—similar to Peru's live-shearing vicuña program—could enhance the conservation of guanacos, because local landowners would be more motivated to help protect the animals if they were able to earn income from live-shearing.

If these programs move forward, and people can legally shear vicuñas and guanacos on a large scale while leaving the animals wild and free, it will represent an ingenious twist in the age-old story of domestication and the newer story of conservation. *Z*

—Mary-Russell Roberson is a contributing editor who last wrote about gliding animals in the September/October 2007 issue of *ZooGoer*.



# Saving the Amazing

## No Way Home: The Decline of the World's Great Animal Migrations

David S. Wilcove. 2007. Island Press, Washington, D.C. 245 pp., hardbound. \$24.95.

In the dusky light, it looked at first glance as if the pine trees wore fall-colored leaves, not needles. A closer look revealed thousands of black-and-orange monarchs blanketing the trees' branches. Yes, thousands—2,000 was the expert estimate—of butterflies cloaked three or four small pines as a few latecomers fluttered about looking for a berth. Spectacular, especially considering the trees were basically in a suburban backyard.

The next day they were gone, continuing a journey that would take the survivors to a few patches of firs in Mexico, thousands of miles away. Later, from the deck of the Cape May-Lewes Ferry, I spotted some brave butterflies crossing the open water of the Delaware Bay, an oddly moving experience.

It was mid-October in Cape May, New Jersey, a migration watcher's mecca. People flock to this peninsula that juts into the Delaware Bay to immerse themselves in the surge of birds and butterflies that break their journey south here. Hawk watchers scan the sky from a comfortable deck at Cape May Point State Park and count hundreds of soaring raptors a day. Other birders take to field and forest looking and listening for some of the millions of small warblers, tanagers, and swallows that pass through here. Clouds of monarchs feeding on blossoming goldenrod are easier to see. So too are dashing green darners, large dragonflies that have been sighted in the hundreds of thousands here. Bottlenose dolphins may be visible from the beach, lazily swimming toward warmer southern waters.

If you live anywhere nearby and have never made the pilgrimage to Cape May, now's the time, and be sure to take the kids. Because, as David S. Wilcove relates in *No Way Home*, great animal migrations are disappearing. Some North American ones are already gone:

Miles-long flocks of passenger pigeons no longer blot out the sun, bison no longer roar across the plains between winter and summer ranges, and Atlantic salmon intent on spawning no longer clog East Coast rivers.

Wilcove explores these tragedies and others in the making. As the work of the Smithsonian National Zoo's Migratory Bird Center attests, Neotropical migrants like the warblers that pass through Cape May are in trouble. They are beset by habitat loss and fragmentation on their northern breeding and southern wintering grounds as well as at rest and refueling spots in between. Old World songbirds migrating between Europe and Africa face a different threat: Hunters shoot and eat huge numbers of them both north and south of the Mediterranean.

The African wildebeest migration between the Serengeti and the Maasai Mara is among the strongest of remaining mammal migrations. It still involves a million animals and most of their range is contained within protected areas. But farms and settlements are crowding the edges of these reserves, leaving no room for changes in migratory routes that are all but inevitable in the future. However, in South Africa, the migration of springbok, which once rivaled that of wildebeests in scale, is gone even though, like American bison, springbok survive. Wilcove makes the crucial point: "What is gone is not the species but the phenomenon of the species, the spectacle of hundreds of thousands of springbok marching across the Karoo desert, kicking up great clouds of dust, as they wander in search of forage."

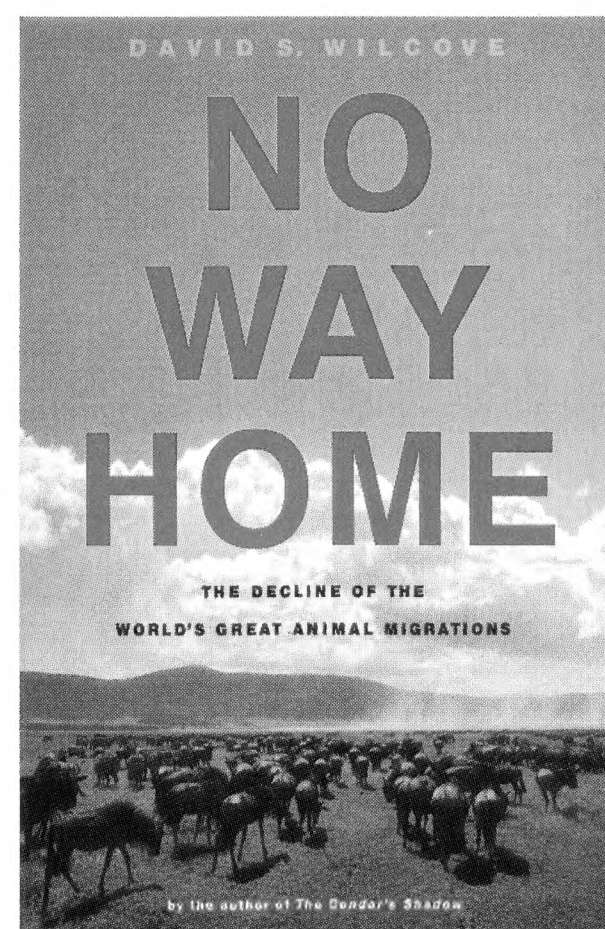
Wilcove reports on the peripatetic lives of these and many other species, from right whales and sea turtles to locusts and horseshoe crabs. He reviews what scientists have learned about how some of these animals accomplish such amazing feats of navigation and endurance, and how much remains to be learned. No one knows, for instance, where green darners go for the winter or how a female loggerhead turtle finds its natal beach to lay eggs—25 or 35 years after it was last there as a day-old hatchling!

He also explores the havoc climate change may wreak on migratory patterns. Already there is evidence of timing mismatches between the birds' arrival on breeding grounds, which is cued to changes in day length, and the emergence of insect prey, which is dictated by temperature. For example, pied flycatchers

have declined by about 90 percent over the past 20 years in the Netherlands because warming temperatures mean that the caterpillars they relied on to feed their nestlings are peaking too soon. Other dislocations are likely in the future. Where, for instance, will sea turtles lay their eggs when rising sea levels inundate their natal beaches?

Wilcove suggests "the hopeful possibility that ongoing efforts to address global climate change will spawn agreements and partnerships that can serve as models for addressing the plight of migratory animals." This is the only way that such species, many of which move in and out of the jurisdictions of dozens of countries and the phenomena of their migratory lives, will be saved. That said, I suggest not waiting too long to see some of these spectacles for yourself.

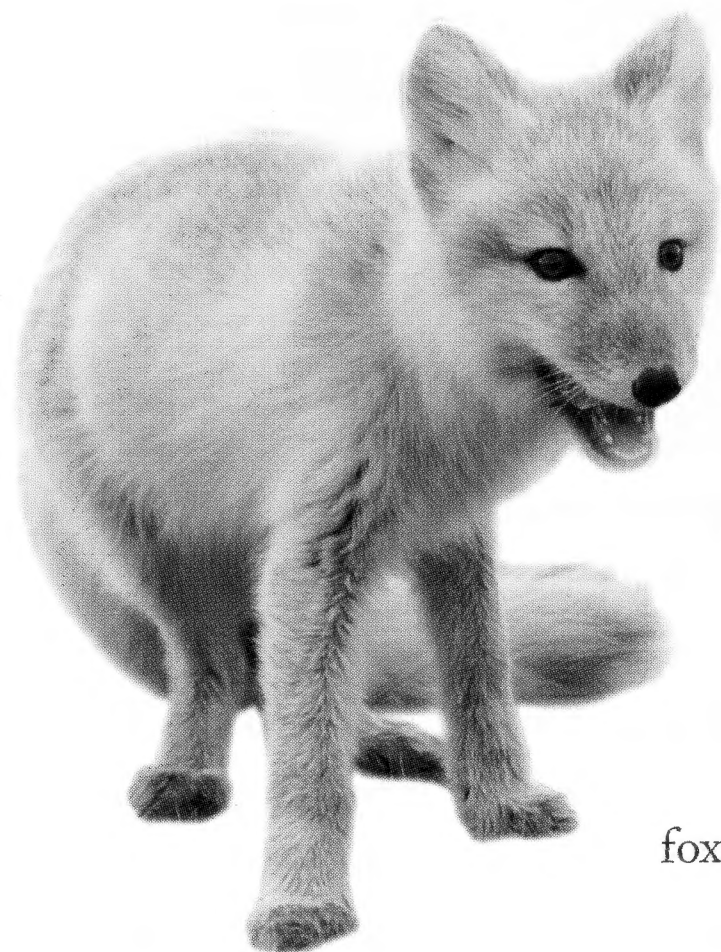
—Susan Lumpkin





## Cold Storage

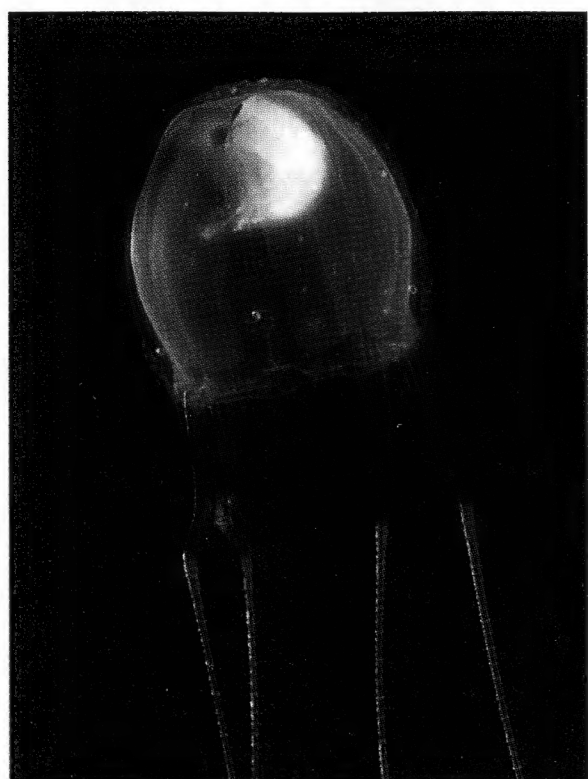
Talk about stocking up for the winter. Arctic foxes (*Alopex lagopus*) in northwestern Canada cache more than 1,000 goose eggs apiece each summer to sustain them through leaner seasons. While most carnivores must eat their cached food quickly before it spoils, the foxes have up to a year to eat hoarded eggs, which are protected from decay by their shells, inner membranes, chemicals in their albumen, and the chilly Arctic weather. A



study published in the September 2007 issue of the *Journal of Animal Ecology* is the first to show that the quantity of cached eggs the foxes consume is directly influenced by the availability of the collared lemming (*Dicrostonyx groenlandicus*), the foxes' favorite prey. Collared lemming populations wax and wane dramatically over three- to five-year cycles. In years when lemmings are abundant, cached eggs contribute less than 28 percent of the diet of the foxes in the Queen Maud Gulf Bird Sanctuary in Nunavut, Canada. But in years when lemmings are scarce, as much as 74 percent of the foxes' diet is composed of cached eggs.

## What's in a Name?

The Irukandji jellyfish (*Carukia barnesi*) found near Cairns, Australia, is named for the painful and sometimes deadly syndrome its sting induces. In the 1950s, physician Hugo Flecker examined patients along the north Queensland coast who experienced nausea, back pain, abdominal cramps, elevated blood pressure, rapid heartbeat, and a feeling of impending doom. He dubbed these collective symptoms "Irukandji syndrome" after an indigenous people living nearby, but could not iden-

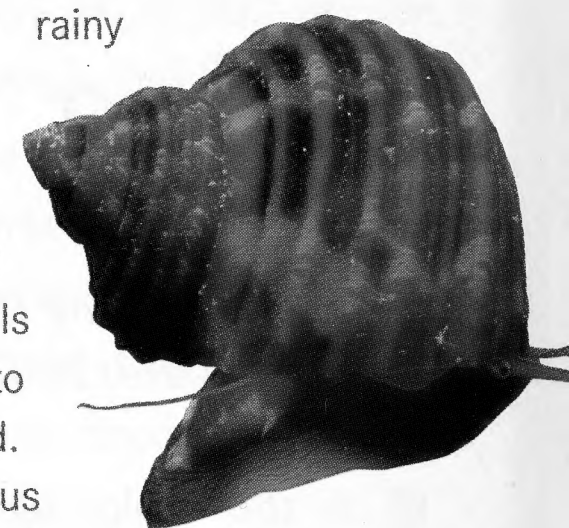


tify which jellyfish caused them. More than a decade later another physician, Jack Barnes, suspected a thumb-size, quick-swimming box jellyfish was the culprit. He tested his theory by allowing it to sting him, his nine-year-old son, and a lifeguard, and was proven correct when the signature symptoms set in. As a tribute to him, the jellyfish's species name is *barnesi*. Experts now suspect that several other species of box jellyfish also cause Irukandji syndrome.

An eastern pygmy possum (*Cercartetus nanus*) recently broke the world record for longest hibernation. It slept 367 days in a lab at the University of New England in Armidale, New South Wales, in Australia.

## Why Do Slugs and Snails Leave a Slime Trail?

The morning after a rainy night, you don't have to look far to find the glistening, silvery trails left by slugs and snails. These animals use a muscular foot to move along the ground. The foot secretes mucus tracks that ease locomotion, prevent the loss of body moisture, and protect the foot from surfaces as sharp as a razor. Mucus production is energetically taxing, so snails and slugs sometimes reuse existing trails.

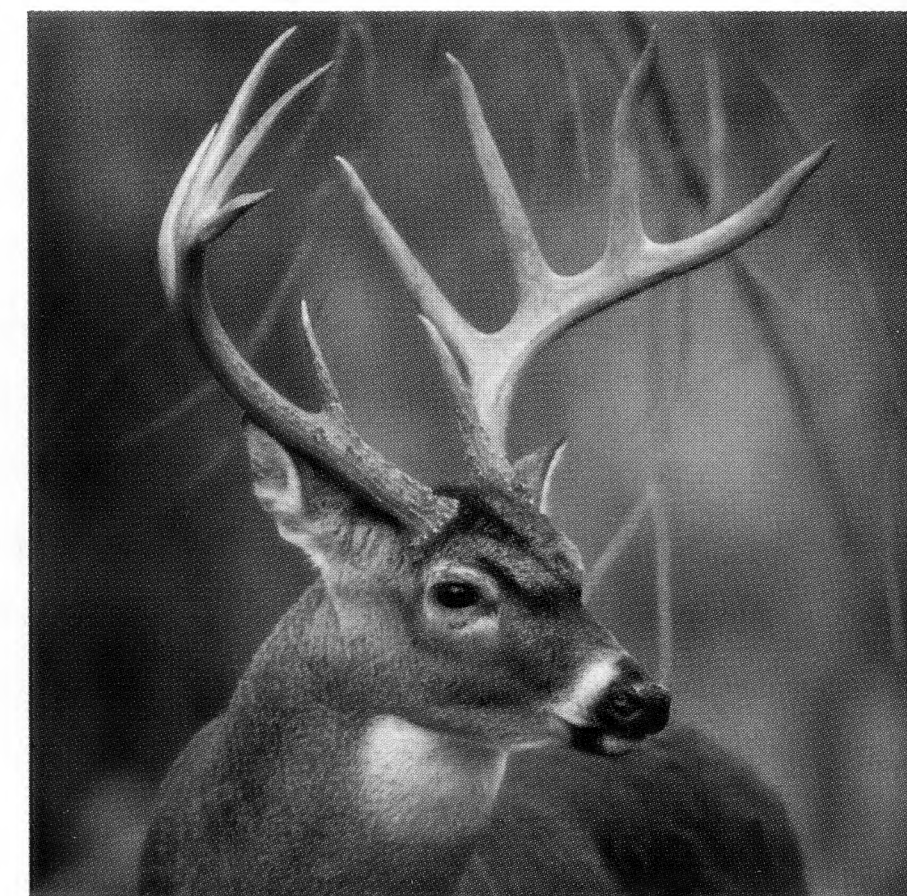


## Fact or Fiction: Animals Anticipate Natural Disasters

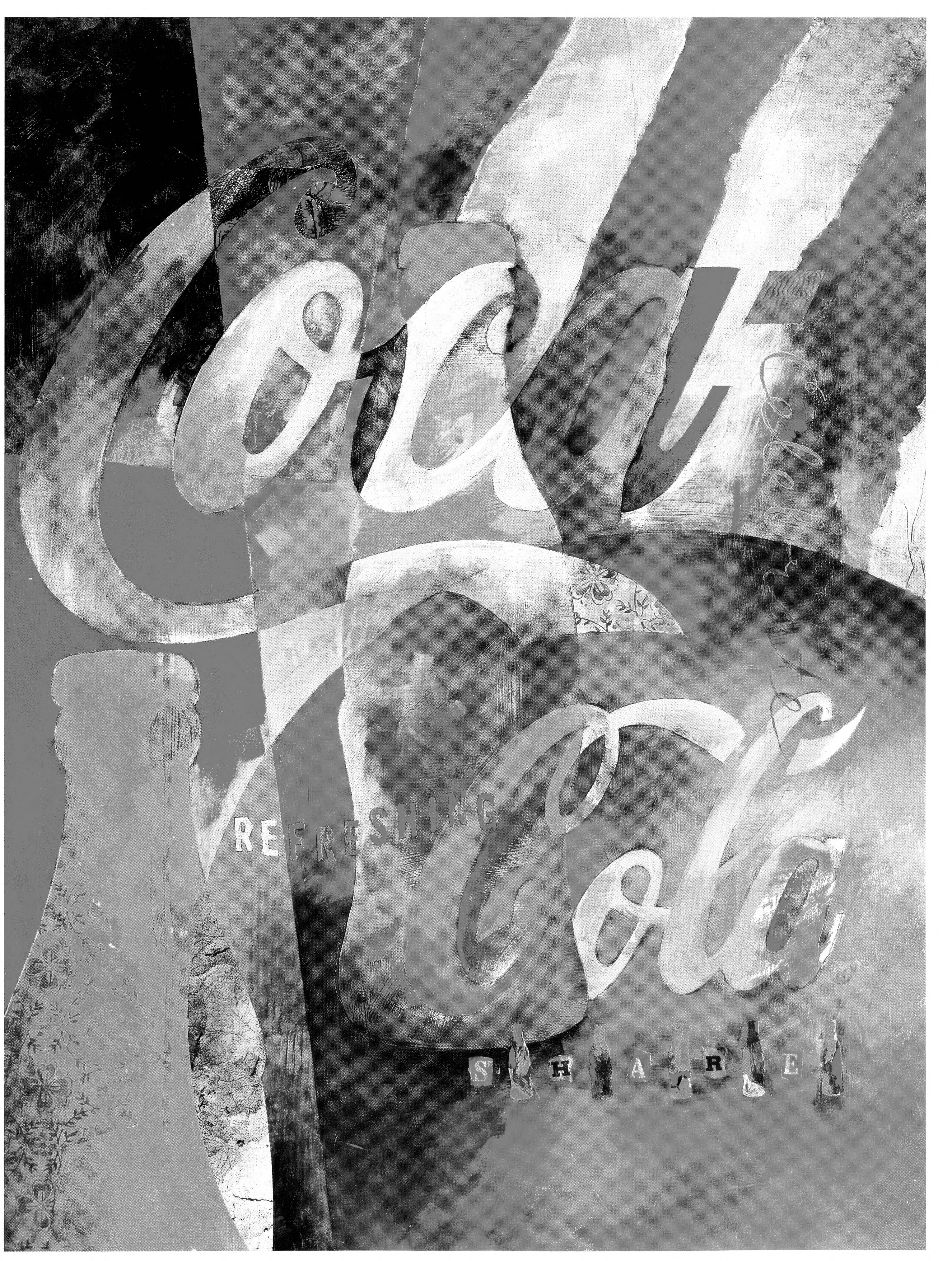
There are many anecdotes about animals with a "sixth sense" fleeing days before a natural disaster occurs. It is true that animals often have more finely tuned senses than humans—elephants, for example, have sensitive touch receptors on their feet and can detect seismic vibrations from nearly 20 miles away. Yet a Smithsonian's National Zoo scientist and his colleagues tracking two Asian elephants (*Elephas maximus*) in Sri Lanka did not observe the pachyderms exhibiting any unusual behaviors before the tsunami that hit the island in 2004. So far, no scientific study has conclusively proven that animals have premonitions about natural disasters far ahead of time.

## In Season

January marks the end of the rutting season for white-tailed deer (*Odocoileus virginianus*), when males—or bucks—start to shed the antlers they used to challenge competitors for mates. New antlers composed of bone begin growing in the spring and are covered in skin called "velvet." During the fall rutting season, the antlers harden and bucks rub off the velvet.











**MANY ANIMALS HIBERNATE WHEN IT GETS COLD. BUT WHY SHOULD YOU?**

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